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DISSEMINATION OF PLANTS.

THE population of a country does not consist solely of the natives or of the descendants of the families who have inhabited it for several centuries. The most diverse accidents lead foreigners thither, who become established and naturalized and confounded in a few generations with the primitive inhabitants. The same is the case with vegetable populations. A flora consists of indigenous species known from time immemorial in the country, and of others that have been introduced into it by various causes.

Nature, in fixing plants to the soil by their roots, seems to have deprived them of the means of propagating themselves to a distance; but she has happily modified this severe law by providing the seeds with appendages that permit them to be carried to a distance from their native country by the natural powerful agents. The wind, watercourses, animals, and man himself voluntarily or unconsciously baffle the rules established by the naturalist.

Of all the natural agents, the wind is the one that takes the greatest part in the work of dissemination, because of the frequency and violence of its action. The hurricane of the tropical regions, whose velocity reaches 85 and even 100 miles per hour, and which uproots trees and makes great ravages in cities, is capable, in a very short time, of carrying seeds, and even entire plants, beyond seas and straits. Certain seeds are provided with appendages of which the object is to aid in the dissemination by the wind. Such seeds Mr. Mattei, assistant at the Botanical Garden of Boulogne, proposes to call anemophilous (Fig. 1). He divides them into three classes: The first comprises seeds that are provided with wide membraneous appendages, and which, when they fall, turn over in the air like a feather. Such are the fruits of the maple, ash, ailantus, elm, etc. The fruit of the linden behaves in the same way, owing to the wide bract that accompanies their peduncle. The second class embraces seeds or fruits that are light, flat, and surrounded with a membraneous expansion of varying width, such as alyssum, honesty, and woad. The third class is the one perhaps which best favors dissemination by the wind. It consists of fruits surmounted by a feathery tuft or entirely covered with hair or silk. To this class belong nearly all of the Compositæ, several Graminiæ and Valerianaceæ; the species of the genera *Asclepias* and *Clematis*, and *Anemone pulsatilla*. The silky seeds of the cotton plant, the poplars, the willows, etc., occupy a place in this category.

The wind, in its action, often carries seeds to places where they cannot germinate; so, anemophilous plants are generally possessed of a large number, and, for this reason, both the preservation of the species and its dispersion are assured.

This faculty of dissemination, in connection with the great number of the seeds of the Compositæ, constitutes a serious inconvenience for the farmer, whose fields too often become overrun with thistles. The pampas in the vicinity of Buenos Ayres have been invaded by thistles imported from Europe, which have developed upon the shores of the sea, and which the winds from the offing have spread broadcast inland. Certain plants have seeds that are in the form of powder, like fine sawdust, such, for example, as the orchids and broomrapes. An epiphytal orchid belonging to the genus *Stanhopæa* allows a cloud of seeds to escape when it is disturbed by the gentlest breeze. The cryptogams have numerous spores of extreme tenuity, and the dispersion of which is very easily effected. We find them everywhere. We run across lichens up to the limit of the eternal snows, and, according to Linnæus, "the white lichens alone vegetate in cold Lapland—the most distant of habitable lands. The last of plants covers the last of the lands."

Rivers and other streams carry into the valleys such seeds as have fallen into the.r currents or that they have swept along in their overflow. Walnut trees, oaks, chestnut trees, etc., are often disseminated in this way. The lotus or *nelumbo* of the Nile (Fig. 2), the rose lily of Herodotus or lotus of the ancients, the edible root of which made those who partook of it forget their own country, has very light seeds which accomplish true voyages upon the Nile before landing upon a bank where they can germinate. According to Dioscorides, the Egyptians, in order to reproduce the *nelumbo*, were obliged to envelop the seeds in ooze to keep them at the bottom of the river.

"The carriage of seeds by floating ice is not a gratuitous hypothesis," says Chas. Martius. "The navigators of the polar seas have often met with pieces of ice charged with a huge mass of *debris* mixed with earth or gravel. Plants vegetate upon such debris as they would upon the superficial moraines of the glaciers of the Alps, and when the ice becomes stranded upon a distant soil, it deposits thereon, so to speak, plants that afterward spread through the country."

Marine currents are more effective agents of dissemination. The cocoanuts of the Seychelles Islands traverse the Indian Ocean and travel as far as to Sumatra. The cocoanut trees spontaneous in the islands of Polynesia have thus spread over the coasts of Brazil, of Guiana, and of Congo. Seeds of plants indigenous to the Antilles and to Jamaica are carried by the Gulf Stream to the shores of Iceland and Norway; but they cannot germinate for want of a proper temperature.

Darwin made some experiments to ascertain how long seeds and fruits can resist the injurious action of sea water. Sixty-four species out of eighty-seven germinated after twenty-eight hours' immersion in salt water; several even supported an immersion of thirty-seven days. Taking the mean velocity of the oceanic currents into consideration, he concludes that a very large number of seeds can be transported through 960 miles of sea without losing their power of germination.

At Port Elizabeth (Southern Africa) there was remarked in 1887 large quantities of pumice stone that had been brought in by the sea. In this were found various animals unknown to the country, and a sort of cocoanut. This was planted, and produced a palm tree strange to the coast of Africa. These animals and this nut were driven from their habitat at the time of the eruption of Krakatoa in August, 1883, and carried as far as to *terra firma*. This mode of plant dispersion is worthy of remark.

Dr. Marino Borbiconi calls such fruits eriophilous as are provided with spines or hooks that attach themselves to the fur of animals, which carry them to a distance, either in their daily excursions or in their annual migrations (Fig. 3). Such are the sainfoins, several kinds of luzerne, agremonies, carrots, etc.

At Port Juvenal, near Montpellier, they dry upon cobble stones exposed to the heat of the sun, and which cover humid earth, wools derived from the ports of the Levant, of the Black Sea or of Buenos Ayres.

Seeds attached to the fleece drop and germinate between the stones. They have thus formed, at Port Juvenal, a special flora, of which Messrs. Godron and Cosson have described 475 species as American, Asiatic, or African.

The fruits of the grasses often remain covered by the glumes, whose sharp edges or fine hooks form a powerful organ of adherence. The glumelets are sometimes sharp enough to pierce the skin of sheep, and so follow these animals in their migrations. By an admirable adaptation, the herbivora, which seemed destined to destroy forage plants, propagate them unknowingly by carrying around with them the fruits hooked to their fur or wool.

Many persons, says Linnæus, not considering that the fecundity of seeds is not altered by this passage through the stomach of animals, find it strange that a well filled field sown with the best wheat often produces darnel or wild oats, especially when it is manured with fresh dung. The storing of certain seeds in the stomach of animals often makes them better adapted for germination.

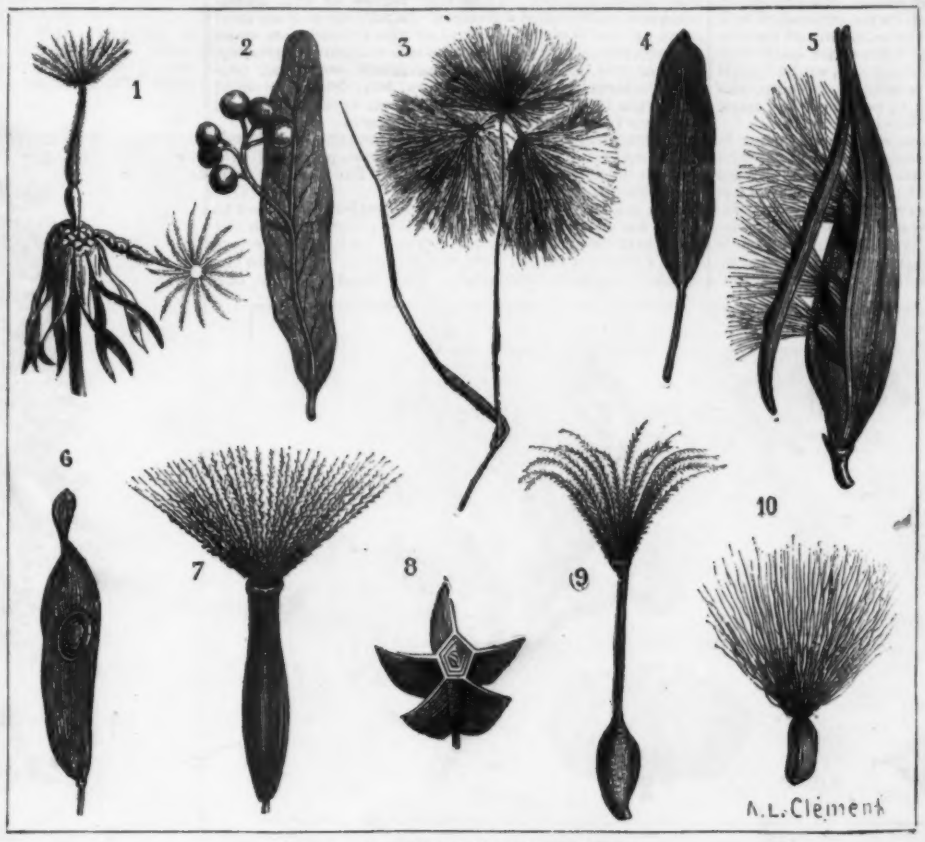


FIG. 1.—ANEMOPHILOUS PLANTS.

1. *Urospermum picroides*. 2. *Tilia* with its bract. 3. *Eriophorum angustifolium*. 4. *Fraxinus excelsior*. 5. *Asclepias vincetoxicum*. 6. *Ailantus*. 7. *Hieracium glaucum*. 8. *Combretum secundum* (transverse section). 9. *Helminthia echioides*. 10. *Epilobium*.

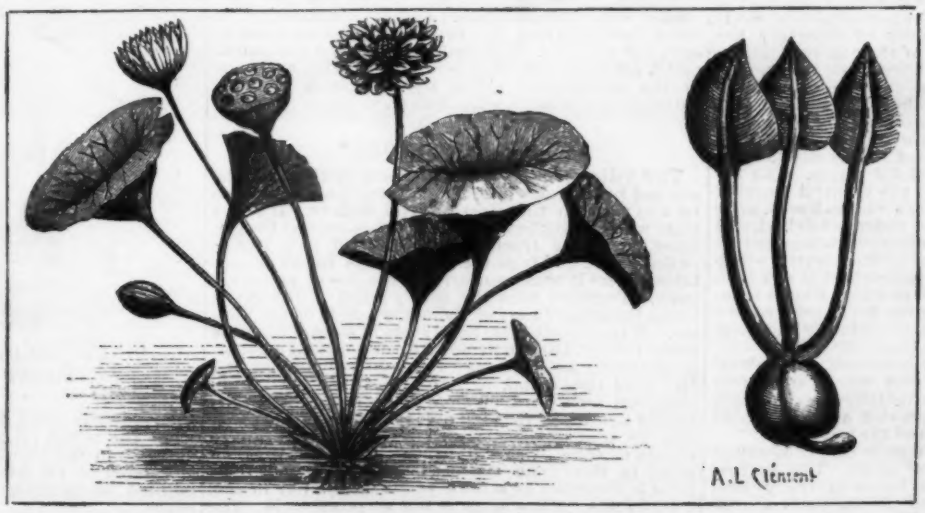


FIG. 2.—THE NILE LOTUS.

To the right, the same plant according to the Erbario of Castore Durante.

Certain agriculturists, wishing to form hedges, feed their turkeys upon whitethorn berries.

They plant the seeds found in the dejections, and they assert that they have in this way secured a year for the increase of their hedge. The brightly colored fruits with hard and coriaceous seeds are generally disseminated by birds. In the seventeenth century, the Dutch, desiring to preserve the monopoly of the nutmeg trade, destroyed all the nutmeg trees that they met with outside of their possessions. But the wood pigeons of the Moluccas, by carrying nutmegs to the neighboring islands, thwarted this work of destruction.

If there is one example that stands above all others, when it is a question of dissemination by birds, it is indeed that of the mistletoe (*Viscum album*). All authors, in fact, say that the thrushes, which are very fond of the fruit of this parasite, deposit its seeds, with their excrement, upon the branches of trees, to which they adhere on account of their viscosity, and on which they germinate. Mr. G. Mattei disapproves of this assertion. The following are the objections that he makes to the classical theory. It is not necessary to bring into the question the viscosity of the fruit, since all the pulpy mass is destroyed by the action of the gastric juice, and we find in the dejections naked seeds only.

In addition to the fact that it is quite rare, seeing the position that the birds occupy upon the branches, that their excrement does not fall to the ground, it will prove to be a true accident if the seeds found on the branch are deposited at a point where the bark has been removed. For it is at such a point, and at such a point only, that the parasite is able to develop, the plantlet not having the strength to perforate the bark in order to work its way to the wood.

According to the Italian botanist, the following is what really occurs. The thrushes, attracted by the beautiful white color of the fruit and enticed by its sweetish taste, try to seize it, but the fruit remains adherent to their bill. In order to rid themselves of it, they rub it against the branches with that characteristic motion of birds when they wish to sharpen their bill, and, meeting with some slight crack in the bark, they leave therein the fruit that incommodes them.

Wars, which occasion extensive shiftings of men and baggage, are an important factor in the work of dissemination. The conquests of Alexander, the ancient expeditions of the Romans, those of Napoleon and the crusades, have carried plants from one extremity of the world to the other. In 1814, the Eastern *Bunias* followed the Russian army through Germany up to the gates of France, and plants of the banks of the Don and Dnieper made their appearance in the valley of the Rhone. In 1873, 163 species, introduced with German forage, were found in Loir-et-Char. In the neighborhood of Strasbourg are shown 84 Algerian species which came with the French troops called back from Algeria.

The introduction of cereals and of foreign agricultural products introduces new plants. When the English introduced cattle into New England, the first common plant observed was the nettle. *Per contra*, two Canadian plants have rapidly spread in France: one of these, the Canada fleabane, a coarse composite, introduced with cereals, is now common upon every wall; the other, the *Elodea Canadensis*, a small aquatic plant, has invaded our rivers, and has developed to such an extent as to prove a serious obstacle to navigation at certain places. So the Germans have named it the water pest.

The exit of seeds and their dispersion to a short distance is often favored by the elasticity of certain parts of the fruit. This is what we may style auto-dynamic dissemination. Thus the valves of the Balsaminaceæ (particularly those of *Impatiens noli-me-tangere*), of the Geraniaceæ, and of the Oxalidaceæ, open with elasticity and shoot their seeds to quite a distance. One of the Euphorbiaceæ, the *Hura crepitans*, produces a large fruit called the sand box. This is divided into from 12 to 18 divisions, which, on drying, open and separate from the axis with an explosion.

A cucurbit (*Ecbalium elaterium*) detaches itself suddenly from its pedicel; the seeds, accompanied with a certain liquid, are ejected through the opening thus produced.

The most curious case of dissemination is offered to us by the rose of Jericho. This little plant grows in the most arid deserts. Through dryness its branches curve so as to form a sort of ball, and the plant is fixed to the earth by a slender root only. The wind uproots this

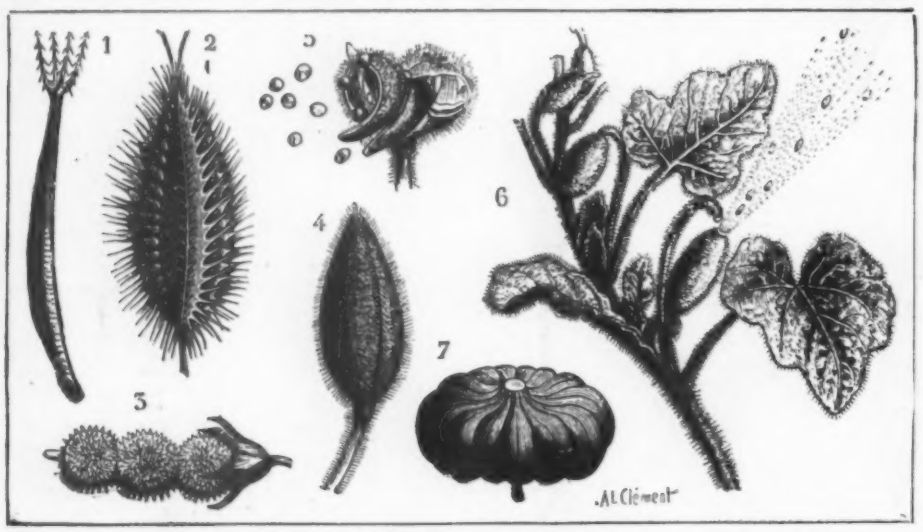


FIG. 3.—ERIOPHILOUS FRUITS.

1. *Bidens pilosa*. 2. Fruit of carrot (magnified). 3. Sainfoin (fruits disseminated autodynamically). 4. Fruit of balsams. 5. The same opening at maturity. 6. *Momordica*. 7. Fruit of *Hura crepitans*.

The seeds are then placed in good conditions for germinating and developing. The explanation appears to us ingenious, and we bring it to the attention of naturalists, who have an opportunity of observing the habits of the thrushes. Birds, in their annual migrations, carry seeds derived from different climates. The earth that sticks to their feet, and the mud of the marshes in which they have dabbled and which soils their feathers, often contains seeds capable of germinations. Darwin tells us that three spoonfuls of mud taken from a pond and cultivated for six months produced the surprising number of 537 plants. The following is what may have been the eventful travel of many seeds. Falling into the sea, the frail seed, after traversing quite a wide extent of water, is left high and dry by the tide, upon a far-off shore. It is ingested by a bird, which flies to the interior of the country, where it becomes the prey of some rapacious bird or of a hunter's bullet. The sudden death to which a large number of frugivorous or granivorous birds are exposed favors the carriage of seed to places whither the natural agents alone could not take them.

The higher animals, the great herbivora, carry about in their stomachs hard, bulky seed which can remain therein without losing their germinative quality; such are the dates, the guavas, etc., which are propagated by the buffalo, the rhinoceros and the elephant.

In Java, a species of civette is, so to speak, intrusted with the dissemination of coffee seeds. The squirrel lays up a supply of fruits that it buries in the ground or in the trunk of a hollow tree. If the seeds are unearthed, they will germinate. This fact is well known to the Indians, among whom there is a tradition that all the forests of the country were planted by the squirrels.

Man is the most active agent of dissemination. We shall consider only his unconscious and involuntary action. Certain plants are closely attached to man, and accompany him everywhere. Plants that grow on walls and in the yard are of this number. Their seeds, which are very tenacious, attach themselves to his clothing, are in his aliments, and propagate themselves with him, betraying his permanent or momentary presence. We find them everywhere, even upon the mountains, where a herdsman has established his hut, even but for a few days; such are the nettles that are found only near dwellings, the groundsel, the arse-smart, the mallows, the pimpernel, etc.

ball and makes it roll over the sandy plains. If, during this forced but necessary voyage, the ball meets with a pool of water, the moisture, promptly absorbed by the dried tissues, causes the branches to expand and to open the pericarp. The seeds, falling upon the humid earth, are then capable of developing. Such are some of the means that secure the dispersion of seeds throughout the earth.—*La Nature*.

PINUS PONDEROSA.*

THE yellow pine of the Californian settlers was discovered by Douglas in 1827, and introduced to Europe by him through the Horticultural Society. It is the most widely distributed of the Californian and Oregon pines, extending from the mountains of New Mexico to Columbia, and from the coast to the Rocky Mountains, where it reaches nearly to the line of perpetual snow. Together with the nearly allied P. Jeffreyi, it forms the greater part of the noble forests of the Sierras. It is a stately tree, hardly less in stature than the sugar pine (P. Lambertiana). Its trunk attains a height of 150 to 200, and even 300 feet, and a diameter, at 3 feet from the ground, of 6 to 7 feet; the shaft is unbranched for a third or more of its height, and then breaks up into a regular, oblong, columnar head, as may be seen in the illustration. The leaves are in groups of three, each 4 to 10 inches in length, and radiating in tufts from the ends of the branches. The color is described as a dark yellow green, but in this country the yellow tinge is not so perceptible. The successive appearance and decadence of clusters of leaves gives, says Dr. Newberry, the smaller branches a beaded character, which distinguishes this from other Western pines.

The cones are from 3 to 6 inches long, ovoid, the bosses of the scales bearing small acute recurved spines. The cones grow singly, or in clusters of two to four at the extremity of the small branches, and are not pendent. The bark is cork colored, or yellowish brown internally, and divided into large plates or flakes 4 to 8 inches in breadth, and which are flat and smooth, and enable the botanist to distinguish the tree at a considerable distance. The wood is highly resinous, heavy, brittle, but the sap wood is very thin in proportion to the heart wood, and consequently the timber is of very great value, although inferior to that of the sugar pine (Lambertiana).

The seedling plants are robust, with a strong root-system branching from the base, and the primary stem, already in the second year, showing indications of

PINUS PONDEROSA, SHOWING THE HABIT OF THE TREE.

the columnar trunk it is destined hereafter to form, while the tufted primordial leaves suggest a possible ancestor in the humble Isoetes. The primordial stem is covered on all sides with alternate, linear, sharply pointed leaves about 1½ inches long, serrated at the edges.

In the second biennial report of the California State Board of Forestry, Mr. J. G. Lemmon classes this pine with P. Jeffreyi, under his section of "broken-cone" pines, owing to the peculiarity the cone possesses of breaking off when ripe near to but not quite at the base, so that a few scales are left on the bough, while the bulk of the cone falls to the ground. In a fine tree growing in Slocock's nursery at Woking, this characteristic is very apparent. The individual scales are provided with a short stalk, which is flattened at right angles to the expanded part of the scale like the petiole of the aspen, and the detachment of the scales is probably connected with this peculiarity.

Occurring over such a vast extent of country, and at such different elevations and aspects, it is not wonderful that many variations occur, some of which have been classed as distinct species. Among them is var.

* P. Ponderosa, Douglas, in *Companion to Botanical Magazine*, ii, 111.; Parlatore, in *D. C. Prod.*, xvi., ii., 395 (1868), (excl. P. Sinclairii); Engelmann, in *Bot. California*, ii, 125; Lemmon, *Second Biennial Report California State Board of Forestry* (1888), *Supplement* (1889), p. 6; Fowler, in *Gard. Chron.*, 1872, 1336; Coulter, *Manual of Botony of Rocky Mountains*, 1885, p. 432; Veitch, *Manual* (1881) p. 167. For full bibliography up to 1884, see Sargent, *Forest Trees of North America*, p. 192.

FIGURES.—London, *Arboretum*, iv., t. 232 to 236; Forbes, *Pinetum Woburnense*, 44, t. 15; Antoine, *Conif.*, 29, t. 8; Newberry, in *Pacific R. R. Report*, vi. 36; 90, t. 4, f. 12; J. D. Hooker, in *Gard. Chron.*, 1878, June 22, pp. 796 and 801.

SYNONYMS:
P. Benthamiana, Hartweg; Gordon, in *Journ. Hort. Soc.*, iv. (1849) Fig. 212.
P. resinosa, Torrey.
P. Brachyptera, Engelmann.
P. Beardsleei, Murray.
P. Craigiana, Murray.
P. macrophylla (*P.*), Torrey.
P. Engelmanni, Torrey.
P. Parryana, Gordon, not Engelmann.

Benthamiana, a medium sized tree, a discovery of Hartweg's in 1846, and of which there is a fine specimen at Orwald Park, near Ipswich.

The var. brachyptera is a variety which occurs abundantly in the great volcanic plateau of Arizona and New Mexico.

A third variety is the var. scopulorum, a small spire-shaped tree, not attaining more than 50 feet in height, found in the Rocky Mountains, and often bearing its leaves in pairs instead of in threes. It is the principal timber tree of the Rocky Mountains, one of the hardiest of conifers, and as an ornamental tree it is said to be superior to the type.

This is probably the variety figured in our columns of June 22, 1878, by Sir Joseph Hooker. A weeping variety, grown in Massachusetts, from seeds raised at Knap Hill, Woking, was figured and described in our columns on August 24, 1878, by Mr. H. Winthrop Sargent.

P. Jeffreyi, at one time considered to be a form of ponderosa, is now kept distinct by Mr. Lemmon and others, who have studied the trees in their native habitat. Certainly, in English plantations P. Jeffreyi, which is limited to the Sierras, is very distinct in its glaucous shoots, lemon-like fragrance, and, as may be inferred from the figure of the large blackish cones sent us by Lord Ducie, from Tortworth (Fig. 68, Mar. 23, 1889). The head, says Mr. Lemmon, is large and rounded, limbs long, the bark coarse and reddish.

"I have often feasted," says Mr. Muir, referring to P. ponderosa and Jeffreyi, "on the beauty of these noble trees when they were towering in all their winter grandeur laden with snow; in summer, too, when the brown staminate clusters hang thick among the shimmering needles, and the big purple burrs are ripening in the mellow light: but it is during cloudless wind storms that these colossal pines are most impressively beautiful; then they bow like willows, their leaves streaming forward all in one direction, and when the sun shines upon them at the required angle, entire groves glow as if every leaf was burnished silver. . . . This species also gives forth the finest music to the wind. After listening to it in all kinds of wind, night and day, season after season, I think I could approximate my position on the mountain by this pine music alone. If you would catch the tones of separate needles, climb a tree. They are well tempered, and give forth no uncertain sound, each standing out, with no interference excepting during heavy gales; then you may detect the click of one needle upon another, readily distinguishable from their free, wing-like hum. Some idea of their temper may be drawn from the fact that, notwithstanding they are so long, the vibrations that give rise to the peculiar shimmering of the light are made at the rate of about 250 per minute."

Our illustration represents a tree of the typical form growing on Mount Shasta, which shows its noble habit. This is copied from Mr. Lemmon's report above mentioned. The foliage and cones are represented from a fine specimen in Mr. Slocock's nursery at Woking. The outline in London's *Arboretum* shows a deformed and abortive cone, and no other figure readily accessible to English readers exists. The section of the leaf shows a boat-shaped outline raised in the center, with two layers of hypoderm, numerous resin canals in the texture of the leaf, each surrounded by strengthening cells, and in the center a double vascular bundle, surrounded by an elliptical endoderm, or bundle sheath.
—*Gardeners' Chronicle.*

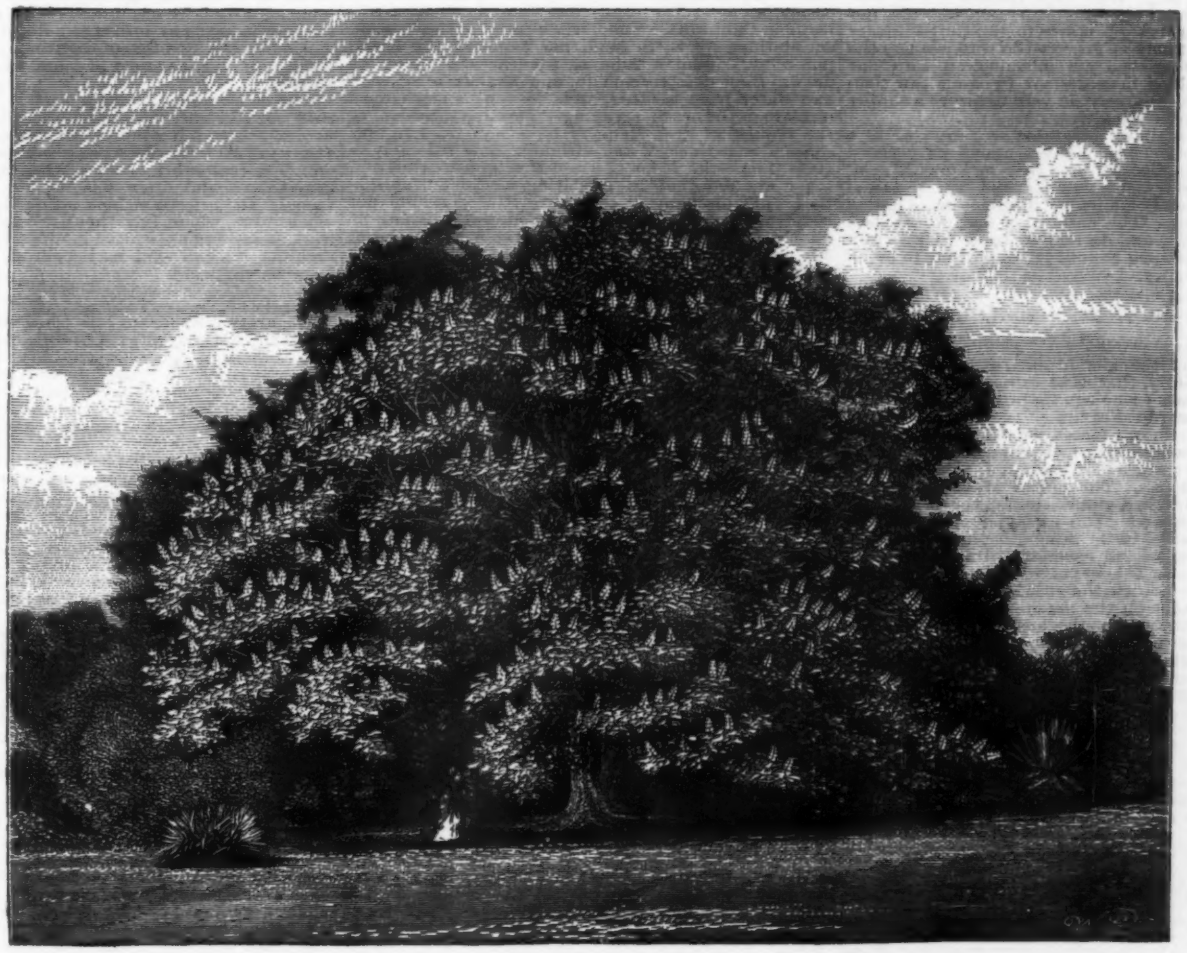
THE CATALPA.

THE genus Catalpa is eastern American and eastern Asiatic in the distribution of its species. Two of these occur in North America, one in the West Indies, one in Japan, and one in the northern regions of China. They are all trees with ample, generally opposite, simple leaves, large terminal panicles of showy flowers, and long, slender, nearly cylindrical, capsular pods. The flowers, which appear in all the extra-tropical species in early summer, are characterized by the deeply two-lipped calyx, the irregularly two-lipped, bell-shaped corolla, which is white, and conspicuously marked with purple and yellow in the throat, and by two, or rarely four, fertile and one or three sterile, rudimentary stamens. The capsule is divided into two cells by a partition which is at right angles to its valves. The seeds are numerous, and densely packed in the cells of the pod; they are furnished on each end with long, papery wings, cut at the extremity into delicate white fringe.

The familiar species, and the type of the genus as it is now constituted, is Catalpa bignonoides, the Catalpa tree, or Indian bean (see cut). It is a low, wide-branched tree, with a short, stout trunk covered with thin, pale, furrowed bark. The wood, like that of the other species, is light brown, and contains numerous large open ducts, which mark the layers of growth. The wood of all the species is remarkable for the thin sap-wood, which consists of three or four layers of annual growth only. The leaves, which emit a disagreeable odor when crushed, are cordate at the base, somewhat acuminate, and are occasionally provided with a pair of salient lateral teeth. They are light yellow-green in color, and do not unfold until nearly all other trees are covered with foliage. The flowers open at the North late in June, or during the early days of July; they are produced in very large, compact panicles, and are about an inch or an inch and a half long. They are peculiar in their campanulate corolla, with an oblique limb and entire lower lobe. The inner surface is thickly covered with purple spots, and is streaked with yellow.

This tree has much to recommend it as an ornament for the garden. It is hardy, it grows rapidly, it is not very particular about soil, and insects do not prey upon its foliage. The large, brilliant leaves have an almost tropical appearance, and the flowers, which appear late in the season, when flowers are particularly valuable, are produced in the greatest profusion. There are few trees, certainly, of temperate regions which present a more remarkable floral display than a large catalpa tree in full bloom. These qualities have made the catalpa one of the most popular trees in all the temperate regions of the world; indeed, it has been cultivated so long, and has now become so completely established in many parts of the Southern States, that it is not easy to determine exactly where it grew before man carried the seeds from one part of the country to another.

The catalpa appears to have been first made known to Europeans by Mr. Mark Catesby, the English naturalist, who was in our south Atlantic regions early in the last century, and who is remembered by his handsome "Natural History of Carolina," which appeared in London in 1731. He published an excellent figure of the tree, which he says was unknown to the inhabitants of the settled portions of Carolina until he introduced it from the remoter parts of the country. What Catesby meant by the remoter parts of the country is not clear; but it is hardly probable that he ever penetrated more than one or two hundred miles from the coast, and certainly he never crossed the mountains into the region which is now generally regarded to have been the first home of this tree—southwestern Georgia, and central Alabama and Mississippi. It is probable, therefore, that the catalpa was first brought east of the Alleghany Mountains by the Cherokees, who are known to have been somewhat interested in plants, and that it was from their cultivated plants, or their offspring escaped to the forest, that Catesby obtained the plants for the Carolina planters, and for his English correspondents, to whom he sent the catalpa as early as 1726. Even to this day there is doubt in regard to the true home of the species. It may be seen growing on the banks of the upper Apalachicola and Flint rivers, in southwestern Georgia, so remote from existing habitations that it is difficult to imagine that the seed which has produced these trees could ever have been blown from cultivated plants. Still it is impossible to surmise how far a plant provided with seed so admirably adapted for transportation by the agency of the wind can eventually be carried from an original starting point; and the fact that the catalpa is hardy so far North, and that it has even become naturalized in some parts of Pennsylvania, seems to be an indication that its true home is not in the hot, low, semi-tropical country of the Gulf States, but rather in some still unexplored mountain region of the Apalachian foot-hills, from which it was early carried by the Indians east into Carolina, and southwest into Georgia and Alabama, through which States, and beyond, it has gradually spread, until it is now found over a large area of the Middle and Southern States.



THE CATALPA.

Two well-marked varieties, at least, of this tree have appeared. The first, the so-called Golden Catalpa, has yellow foliage. The second is a dwarf, compact shrub, rarely attaining a height of 6 ft., but spreading widely, and thickly covered with leaves. This curious plant, which is not known to have produced flowers, passes universally in nurseries as Catalpa Bungei, although it has nothing to do with the Chinese species of that name. It is sometimes grafted as a standard on tall stems of the catalpa, and grown in this fashion, it makes a small tree with a compact round head, useful for the decoration of small gardens and city squares.

The second North American catalpa, C. speciosa, was distinguished specifically a few years ago by the late Dr. J. A. Warder, a Nestor among American tree planters in the West. It is a native of the river swamps which abound about the mouth of the Ohio and the adjacent parts of Missouri. Dr. Warder's attention was directed to some catalpa trees planted in the streets of an Ohio town, and found that they grew more rapidly than other individuals planted with them, and that they assumed a more upright manner of growth. He found, too, that the ends of the branches of these trees were not killed in winter, as was the case with many catalpa trees, and that they flowered fully two weeks earlier; that the flowers were considerably larger, and were produced in shorter, fewer-flowered panicles; and that the pods were much larger, and nearly twice as thick. These observations led him, and several botanists, to study these peculiar trees, and it was found that the western catalpas all differed in these respects from the trees which had been ordinarily cultivated in the Eastern and Southern States, and that

instead of one, North America could boast of two species. It was found—and this is probably true of all the species of the genus—that the wood of C. speciosa, although not hard or very heavy, possessed the power of resisting decay in a remarkable manner when placed in contact with the soil. It was found, too, that the young trees grew with astonishing rapidity, and were hardy as far north certainly as the forty-second degree of latitude, and could support the climate and high winds of the Western prairies. These were qualities which Western planters were in search of, and nurserymen at once set about raising the Western catalpa in great quantities. It has so far proved to be all that was expected of it, and millions of these plants have already been planted in the United States, especially in the West.

The other American species, C. longisiliqua, is a large forest tree widely distributed through the West Indies, where it is prized for its hard, handsome wood, used in cabinet making, and known as Spanish oak. The Japanese catalpa, C. Kæmpferi, is a smaller and less beautiful tree than either of its North American relatives. It has darker green foliage, smaller and less showily colored flowers, and slender pods. It is no longer a rare plant in American gardens, where it grows rapidly, flowers and fruits profusely, and is perfectly hardy as far north certainly as eastern Massachusetts. An interesting hybrid between this and one of the American species has now appeared. It is remarkable in characters intermediate between its two parents, in its hardness, and in its vigorous and rapid growth.

The second Asiatic species, C. Bungei, which must not be confounded with the plant found in nurseries under that name, is a native of northern and central China. It is a large tree, with smaller flowers and leaves than those of the American species, and is not yet known in cultivation either in the United States or in Europe. It may be expected to thrive where the ailantus will grow, and its introduction into our plantations has long been desired by American dendrologists, who have sought in vain to secure a supply of seeds of this interesting tree.

Our illustration shows a catalpa tree growing in a garden near Canterbury, planted about sixty years. Its height when measured some years ago was 32 feet, its diameter 60 feet. One hundred and fifty spikes of bloom were counted on a length of three feet of one of the lower boughs. The catalpa is one of the best town trees known, and it is very hard to kill, new shoots appearing when the old trunk appears to be all but dead.—*Garden and Forest.*

THE MOON NOT A GLOBE.

To the Editor of the Scientific American:

Photographs of the moon, taken at full, show, as I think, pretty clearly, that that orb is not a globe in shape. It appears to be egg-shaped, with the small end pointing toward the earth.

When the well known facts are carefully considered, this is precisely what ought to be expected.

Matter at the surface of the moon is acted upon by two important forces. The law of gravity would arrange the matter in a globe around the center, the moon alone considered. The attraction of the earth, being always exerted in the same direction relative to the moon's center, would constantly draw all fluid or plastic matter to the side next the earth.

The sun shines not less than 325 hours consecutively on any given point on the moon's surface. It is not probable that water on the surface would remain frozen under such continued sunshine, so that doubtless the fluid parts of the moon's surface, obeying the constantly acting force that generates the tides on the earth, have long since gathered themselves together on that side of the moon nearest the earth.

This idea is not inconsistent with anything developed by the shadow of the moon in eclipses, nor with any known fact.

Moreover, a careful examination of the appearance of the moon in her different phases will, I think, show that her shades and light parts are inconsistent with globular form. J. C. HODGES.

Morristown, Tenn., December, 1890.

THE OUTLOOK FOR APPLIED ENTOMOLOGY.*

Gentlemen:

You have made it the duty of your presiding officer to give an annual address—a duty the less easy to perform for a new organization than for one which has a history behind it, and not facilitated by my absence in Europe at the time of your organization.

I had thrown together a sort of *resume* of the results obtained during the year in economic entomology, more particularly by the entomologists of the different State stations, in the belief that this would be one of the most appropriate themes to present. But when I learned, from his circular of September 15, that Prof. Forbes intended covering substantially the same ground, and that it was expected of him as one of his duties as chairman of the Committee on Entomology of the Association of Agricultural Colleges and Experiment Stations, it became evident that what I might present in that direction would be substantially anticipating and repeating what we may expect and hope to hear from him.

I will endeavor, therefore, to touch upon a few matters unconnected with station work.

SOME RESULTS FROM THE NATIONAL DEPARTMENT AT WASHINGTON.

The hydrocyanic acid gas treatment against scale insects is becoming more and more common in California and has, to a certain extent, superseded the use of washes, especially against the Red Scale (*Aspidiotus aurantii*). This is largely due to the fact that recent experiments, carried on through Mr. Coquillett, have resulted in a great cheapening of the process. The cost has been reduced to one third, and the bulky machinery mentioned in my report for 1887 has been, for the most part, dispensed with. It has also been found that the use of the process at night is safer and more beneficial in that it lessens the effect of the gas upon the foliage.

* Address of Dr. C. V. Riley at the annual meeting of the Association of Economic Entomologists, Champaign, Ills., November 11 to 14, 1890.

The repeated importation of scale insects from Florida into California has attracted much attention. The species concerned are principally the purple scale (*Mytilaspis citricola*), the long scale (*M. gloverii*), and the chaff scale (*Parlatoria pergandei*). The fact that these insects must have been repeatedly imported into the State in past years, without obtaining a foothold, has been used as an argument against a quarantine, and a great deal of discussion on the subject has been had in the California papers.

From my own observations in the State I am convinced that, where the proper conditions of shade and moisture are obtained, there is no reason why these scale insects should not obtain a foothold, but that they will probably die out in the hotter, drier and less shaded localities. An agent who was sent to Pomona to investigate certain newly planted orange groves of Florida trees found that while the trees were planted a year previously, and had been dipped, according to custom there, in a caustic solution, every tree examined by him bore a few specimens of the purple scale.

The excitement on this subject in California has been fostered by the claims of rival nurserymen, engaged either in the importation of Florida stock or dealing in varieties grown at home; and with so many contrary claims from persons prejudiced by their business interests, it is difficult to extract the truth. A rigid quarantine, not absolutely prohibitive, were wisest, for great injustice might be worked by absolutely prohibitive restrictions. Careful inspection and thorough treatment, if they could be guaranteed, would prove an effective safeguard, but it were unsafe to trust to them without rigid quarantine.

I have commenced a series of experiments upon the black scale (*Lecanium oleæ*), a species which, ordinarily occurring upon the olive, has long damaged citrus fruits in California. The horticulturist of the Wisconsin station, Mr. E. S. Goff, has modified the Nixon pump by adding a tube, so that kerosene may be drawn from one receptacle and a mixture of soap and water from another, thus forming a mechanical mixture in the act of spraying. This modification, at the request of Prof. Henry, I have had tried in this series of experiments, and although it is too early to state the results, it may be said that so little time and labor are required in preparing a stable emulsion that this mechanical substitute will probably not come into general use. In this connection it may be observed that the formulas recommended by some of our most voluminous writers are very misleading and are calculated to produce only a mechanical mixture more or less unstable.

The use of kerosene temporarily combined with water or soap suds by mechanical means dates from many years back. It was a favorite remedy of my friend Thomas Meehan, who recommended it as early as June, 1866, in the *Gardener's Monthly*, in which various later references to it will be found. It was experimented with by others, and I used it successfully in 1872 against an undescribed Lecanium on Austrian pine, as also against Aphides on the place of Mr. Julius Pitman, of St. Louis, and in 1874 and 1875 against the congregated young of the Rocky Mountain locust. But the true and stable kerosene emulsion, which now forms one of the most satisfactory and widely used insecticides, and which requires two parts of the oil to one of the emulsifying agent, violently churned until a stable, butter-like emulsion results, was the outgrowth of my efforts in the investigation of the cotton worm, the milk having been first suggested in 1878 by the late Dr. W. S. Barnard while working at Selma, Ala., and the most satisfactory formula in 1880, from experiments which I had continued over two years by Mr. H. G. Hubbard on orange trees.

A locust outbreak of some interest has occurred in parts of Idaho and Utah and has been investigated by Mr. Bruner, the Nebraska agent of the division. The species involved proved to be *Camnula pellucida*, which has overrun the strip of country, 140 miles in length by from 15 to 30 in width, commencing at a point about 30 miles westward of Soldier, Idaho, and extending east as far as East River and Birch Creek. The people in these sections are quite willing to do whatever can be done to destroy these insects, but they need instruction. The country has been largely settled since the publication of the early reports of the U. S. Entomological Commission, and the new settlers lack experience in dealing with locusts, for fifteen years make great changes in the rapidly growing West.

I have, therefore, in preparation, a bulletin treating of the several species of locusts which are responsible for these frequent scares, and which will include, at the same time, a summary of the practical portions of the earlier reports of the Entomological Commission on *Caloptenus spretus*, long since out of print.

The army worm proved injurious in several localities during the past year, particularly in Maryland and Indiana. The Maryland occurrence is of considerable interest, owing to the fact that the preceding year was one of unusual precipitation, and the outbreak of the insect was due rather to the extremely mild winter, which promoted the constant growth and development of the hibernating larvæ.

The notices in *Insect Life* and the *Entomologist's Monthly Magazine* of the damage caused by a new bark louse to the gardens of Alexandria, Egypt, have attracted considerable attention, and Mr. J. W. Douglas has described the new depredator as *Crossotosoma aegyptiacum*. A study of Mr. Douglas' description and figures has convinced me that this insect is an *Icerya* and that its spread is greatly to be feared, judging from our experience with *I. purchasi*. Moreover, three additional species of this genus have been brought to my notice during the year, one occurring in Mexico on grape vine, another in Key West, Fla., upon roses and other garden plants, and the third in the island of Montserrat, West Indies, upon the cocoa palm, the banana and a species of chrysophyllum. These interesting and injurious insects have been investigated so far as could be done by correspondence, and full descriptions with figures will be published in the forthcoming number of *Insect Life*.

The sugar beet industry after a quarter of a century's vicissitude has begun a substantial and permanent growth, especially in Nebraska. It has been found that the crop is speedily attacked by insects, and Mr. Bruner, being advantageously located for work of this kind, has, during the past summer, paid some attention to the insect enemies of this crop, and has already a list of 64 species, most of them being leaf eaters and such as are commonly found upon various allied succulent plants—one of the worst being the garden webworm (*Eurycreon rantalis*).

THE HOP PHORODON.

One of the most interesting facts of the year has been the occurrence of the hop fly (*Phorodon humuli*) in the extreme Northwest, especially in Oregon and Washington, so soon after my note of warning as to the danger of its introduction to the hop fields of that section, and the need of precautionary measures that might prevent such a calamity. The soil and climate of southern Oregon seem particularly adapted to the growth of the hop, as it is already the leading crop in Lane, Marion, Polk and other counties.

There can be no doubt about the species, because Mr. F. L. Washburn, the entomologist of the Experiment Station, has given it some attention and I have also received specimens from him and from Mr. A. Todd, of Eugene, Oregon, as also from Mr. Giles Farmin and Mr. G. M. Stratton, of Puyallup, Wash.

Mr. Washburn, from the fact that it has been noticed that hops were sometimes not so much affected in the immediate vicinity of plum trees as some distance away, and from the further fact that some of the growers reported that they never saw the insect on the plum, indicates that there must be a different state of affairs in Oregon so far as the life cycle of the insect is concerned from that which prevails in the Eastern States and in Europe. Absolute and experimental proof of facts obtained after long and persistent investigation should never be lightly questioned! It is by no means a common experience that hop plants in the immediate vicinity of plum trees are not more affected than, or as much as, others at a distance, and this may depend on the direction of the wind or on local circumstances, or on the variety of plum, whether wild or cultivated.

I have examined in vain certain cultivated plum trees for evidence of phorodon, whereas I have invariably found it upon other varieties in the same vicinity. *Phorodon humuli*, in common with all other aphidids, preferably chooses, when migrating, certain genial days, and often fills the air, flying great distances. In perfectly calm weather the migrants settle almost everywhere, but they are easily affected by the least breeze and are wafted in different directions. The invasion of a hop yard may be from plum trees miles away to windward.

PHYLLOXERA.

The grape phylloxera has continued to attract the Attention, not only of most European governments, but also of those of Australia and New Zealand. It continues its spread in France, having at last invaded the more valuable champagne districts. The last report of the Superior Phylloxera Commission of that country shows that about 240,000 acres have undergone defensive measures, submersion being employed in 72,000, bisulphide of carbon in 145,000, and sulphocarbonate of potassium in 23,000. The work is practically at an end in such departments as Herault, Gard, and Gironde, where the American resistent vines have most effectually been used, while the vine growers of Algeria, Spain, Italy, Portugal, Hungary, Austria and Switzerland are all battling against it, and are all more or less aided by their respective governments.

The advent of the insect in New Zealand has been the cause of much writing and of much legislation there, and the government has been quite anxious to get the best and latest information on the subject. There is very little that is available in the way of published experience in this country, as my Missouri reports are now very difficult to obtain. I would repeat here in substance what I have recently written to Mr. F. D. Bell, Agent General at London for New Zealand, because the demand for the information is continuous, and our own people are, to a great extent, unfamiliar with the facts.

During the more than twenty years' struggle in France against the species innumerable remedies have been proposed, most of which have proved to be absolutely valueless. A few measures have been devised, however, which, under proper conditions, give fairly satisfactory results. These consist in: 1, methods which avoid the necessity of direct treatment, comprising the use of American stocks and planting in sandy soils; 2, the employment of insecticides (bisulphide of carbon, sulphocarbonate of potassium and the kerosene emulsion); and 3, submersion.

It was early found in the history of this phylloxera that most of the cultivated varieties of American grapevines, as also the wild species, resisted or were little subject to the attacks of the root form (*radicicola*) of the phylloxera, although the leaf gall form (*gallicola*), which in point of fact does little if any permanent damage, occurs in greater numbers on many of our wild and cultivated sorts than on the European grapevines which are all derived from the single species *Vitis vinifera*, and which are so exceedingly subject to the attacks of the root form. This fact was first noticed in France by M. Laliman of Bordeaux, and later by Gaston Bazille of Montpellier, and was independently proved on a more extended scale by my earlier investigations in the United States. The use of American stocks upon which to cultivate the susceptible European varieties has resulted in an enormous trade in certain American seeds and cuttings, and now supersedes all other methods against the phylloxera.

It was my privilege and pleasure to spend a week in August, 1889, among the world-renowned Medoc and Sauterne vineyards of the Bordeaux district in France. Here, by virtue of the rich alluvial soil, and the ease with which the chief vineyards can be submerged, the phylloxera has made slower headway and the opposition to the use of American resistent stocks has been greatest. Yet they have finally vanquished prejudice, and are, either from necessity or choice, rapidly coming into general use. When I say choice, I mean that even where the French vines yet do well and the phylloxera is kept in subjection by other means, it is found that great vigor of growth and increase in healthfulness and yield of fruit result at once from the use of the American stocks.

Without going into a lengthy discussion of the subject of wild American species, those of practical im-

portance to the grape grower are the following: *V. aestivalis, V. riparia* and *V. labrusca.*

The varieties derived from *V. aestivalis* are of value for their fruit as well as for their resistent qualities, and being easily propagated from cuttings they are very often used as stocks. The most important varieties are Jacquez, Herbemont, Black July and Cunningham.

The varieties of *Vitis riparia*, both wild and cultivated, are, on account of their special fitness, almost exclusively employed in France as resistent stocks, for which they easily take first rank. The varieties used are: 1, the wild forms, and, 2, the cultivated varieties—Solonis, Clinton, and Taylor. Of the cultivated varities the Clinton was one of the first vines tried for this purpose, and has been extensively used, with fair satisfaction. The Solonis now ranks above it, but is valueless for any other purpose, on account of the acidity of its grapes. In California the Lenoir, Herbemont and Elvira have been used, but late experience shows that the wild Hiparia is most satisfactory there as it is in France.

The different varieties of *Vitis labrusca* are less resistent to the phylloxera than those above mentioned. Certain varieties have, however, been grown successfully in France, and of these the Concord has given much the best results; but others, Isabella and Catawba for example, succumb there to the root louse, as indeed they do in many sections of this country.

Of the many valuable hybrids obtained from the American species of *Vitis* which are serviceable as stocks, the more important are the Elvira, Noah and Viala. The last named perhaps, of all the resistent varieties, gives the greatest percentage of successful grafts and is admirably adapted for grafting on cuttings.

Early in the study of the subject it was found that the nature of the soil has a very marked influence on the success of the different stocks. The subject has now been quite fully investigated in France, and the latest researches are formulated by the Experimental School at Montpellier in the statement quoted below, which will be of interest as giving the various classes of soils, together with the American vines best adapted to each.

"1. New deep fertile soils: *Riparia* (tomentous and glabrous), *Jacquez, Solonis, Vialla, Taylor* and *Cunningham.*

2. Deep soils somewhat strong, not wet: *Jacquez, Riparia, Solonis, Cunningham, Vialla, Taylor.*

3. Deep soils medium consistency, new and not dry in summer: *Riparia, Jacquez, Solonis, Vialla, Taylor, Black July.*

4. Light pebbly soils, deep, well drained and not too dry in summer: *Jacquez, Riparia* (wild), *Taylor, Rupestris.*

5. Calcareous soils, with subsoil shallow or granitic: *Solonis, Rupestris.*

6. Argillaceous soils, white or gray: *Cunningham.*

7. Argillaceous soils, deep and very wet: *V. cinerea.*

8. Deep sandy fertile soils: *Riparia* (wild), *Solonis, Jacquez, Cunningham, Black July, Rupestris.*

9. Light pebbly soils, dry and barren: *Rupestris, York, Madeira, Riparia* (wild).

10. Deep soils with a tufa base and salt lands: *Solonis.*

11. Soils formed of debris of tufa, but sufficiently deep: *Taylor.*

12. Ferruginous soils, containing red pebbles of silica, deep and somewhat strong, well drained but fresh in summer: All the varieties indicated, and in addition *Herbemont, Clinton, Cynthiana, Marion, Concord, Herman.*"

The accompanying table from the last report of the Superior Phylloxera Commission indicates better than words can tell the steady growth in the use of the American vines:

Years.	American vines covered acres.	Departments.
1881	22,000	17
1882	42,700	23
1883	70,000	28
1884	131,909	34
1885	188,200	34
1886	276,900	37
1887	413,700	38
1888	536,900	43
1889	719,500	44

On the subject of direct remedies, the value of the kerosene emulsion for this purpose has not been properly realized in France because of the relatively high price of petroleum in her grape-growing *departements.* A series of experiments which I made in 1883 showed conclusively its great value for this purpose, as it not only destroys the insect in all stages, but also stimulates root growth.

In this connection I have recently had a series of experiments made through Mr. Albert Koebele's agency, in the Sonoma Valley, Cal., to ascertain the effect upon the phylloxera of certain of the resin washes which proved so valuable when used against the fluted and other scale insects. The results have been quite encouraging, and the experiments have already shown that in the use of these washes we have a valuable addition to the underground remedies. Soaps were made by the use of bicarbonate of soda, sal soda, and caustic soda, each mixed with resin. In the earlier experiments the earth was removed about the base of the vine to a depth of six inches and for a diameter of four feet. Ten gallons of the mixture were poured into each hole and found to penetrate from 12 to 16 inches, or from 18 to 22 inches from the original surface of the ground. Most of the insects, as also the eggs, were destroyed to a depth of 16 inches. In the later experiments the holes were made only about two feet in diameter, and nearly if not quite the same results were obtained with half the amount or five gallons of the mixture. The plan which I have previously adopted for the application of insecticides to underground insects, of washing the mixture in with pure water, was tried with good success. Soon after the first application five gallons of water were added and five gallons more the following day. This would indicate that in the spring, when rains are frequent (occurring almost every day) in the Sonoma Valley, only a small amount of the mixture need be applied and the rains will do the rest, as examination has shown that up to a certain point each application of water intensifies and extends the action of the original insecticide. The best soap was made with bicarbonate of soda, but the results of that made with caustic soda are so little inferior, while the price is so much less, that the caustic soda and resin soap mixture is the one which I would recommend. The formula which was found preferable is as follows:

Caustic soda (77 per cent.).....5 pounds.
Resin.....40 "
Water to make 50 gallons.

The soda should be dissolved over a fire in 4 gallons of water, then the resin should be added and dissolved. After this the required water can be added slowly, while boiling, to make the 50 gallons of the compound. To this water may be added at the rate of 9 gallons for 1, making 500 gallons of the dilute compound, sufficient for 100 large vines, at a cost of only 84 cents, or less than a cent a vine.

Considering the effective way in which the ravaged vineyards of France have been and are being redeemed by the use of resistent American stocks, and considering the efficacy of some of the direct remedies discovered, it is passing strange that no disposition has ever been made of the premium of 300,000 francs offered in the early history of the trouble by the French government. It cannot be awarded to any one person, but should be distributed among those whose labors and discoveries resulted in the several feasible and satisfactory methods of coping with the insect.

INTRODUCTION OF PARASITES AND PREDACEOUS SPECIES.

The success which has attended the introduction from Australia of *Vedalia cardinalis* has been phenomenal. Indeed, few who have not kept in knowledge of the reports and the actual condition of things can appreciate the remarkable character of the results, not only because of the brief period required therefor, but because of the thoroughness of the work of the little ladybird and the moral and financial benefit to orange growers which have followed in its wake.

The striking success of the experiment has served to fix the attention, not only of entomologists, but of fruit growers and farmers, to this mode of dealing with injurious insects, and there is no question but that the cases in which the experiment may be more or less successfully repeated are numerous. Let us hope, therefore, that the moral effect will be as great as its practical effect in opening up means and ways in the future, as it should serve to remove the disposition to deride any expenditure having such results for its object. Many fears have been expressed lest, after sweeping off the Icerya, the Vedalia, being so far as we now know confined to that species for food, should perish, and that the Icerya, preserved in some restricted places undiscovered by its enemy, would again multiply and become destructive. I firmly believe what I wrote in my last annual report as United States entomologist:

"We may hardly hope, however, that the last chapter in the story is written. On the contrary, it is more than probable, and in fact we strongly anticipate, that the Icerya will partially recuperate; that the Vedalia will, after its first victorious spread, gradually decrease for lack of food, and that the remnants of the fluted scale will in the interim multiply and spread again. This contest between the plant feeder and its deadliest enemy will go on with alternate fluctuations in the supremacy of either, varying from year to year according to locality or conditions; but there is no reason to doubt that the Vedalia will continue substantially victorious, and that the power for serious harm, such as the Icerya has done in the past, has been forever destroyed. We have learned, also, that it will always be easy to secure new colonizations of the Vedalia where such may prove necessary, or even new importations should these become desirable."

During the year I have endeavored to return the favors received from Australia and New Zealand by sending there some of the natural enemies of the Codling moth, and from last accounts, though jeopardized by the action of the custom house authorities, the experiment promises success so far as a species of *Raphidia* from California is concerned. I have also endeavored to introduce some of the parasites which attack the Hessian fly in Europe and which do not yet occur in this country. These efforts have been made by correspondence, for you will be surprised to learn that the restrictive clause in the appropriations to the Department of Agriculture for entomological work which limits traveling expenses to the United States is still maintained in the face of the *Vedalia* experience, where, by the expenditure of $1,500, many millions were saved. The maintenance of this restricting clause in the last appropriation bill, under these circumstances, is a travesty on legislative wisdom, and all the more remarkable because done by the Senate in opposition to the House and the recommendations of both the Secretary and Assistant Secretary of Agriculture.

While there is much to be done in this direction in future, I cannot let this occasion pass without giving a note of warning: Success will only come in any particular case when exact knowledge is first obtained and the most thorough scientific methods are then adopted, and we cannot too severely condemn everything that savors of bunkum and ignorance. During the year the press of the country has prominently heralded the fact that a gentleman from San Francisco, especially charged to study certain entomological matters in the East, found, while in Washington, the twice-stabbed lady-bird (*Chilochorus bivulnerus*) "feeding on the woolly aphis right under the windows of the division of entomology of the Department of Agriculture," the inference intended being that the entomologist and his assistants were ignorant of the circumstances. Indeed, a writer in one of the California papers of recent date announced this discovery under the sensational heading, "Another Good Bug: The Woolly Aphis has found its Sedan." How supremely ridiculous this sort of thing appears to the well informed entomologist I need not tell you, but it may be well for the information of the public to say (as I have not alluded to the matter elsewhere) that a number of different species of lady-birds feed upon the woolly aphis, and that it is a rule with the insects of this family not to be select as to the particular aphid they prey upon. *Hippodamia convergens* (the species referred to as the Sedan of the woolly aphis) feeds, over nearly the whole extent of the United States, upon this particular *Schizoneura*, among others, and the fact that both the species referred to feed upon the woolly aphis is well known. That both species are also common upon the Pacific coast, and that their being carried there from the East is like "carrying coals to Newcastle," may not, however, be so generally known. All such efforts as this, carried on by persons unfit, from want of any special knowledge, for the mission, must invariably do harm, not only because of the negative results which follow, but because of the lack of confidence in such work which they will engender in the minds of our legislators.

I should not think of holding any one responsible for newspaper paragraphs, but in this case the party has substantially confirmed them in statements over his own name and in interviews which (as announced) he has himself revised.

(To be continued.)

THE MECHANISM OF INFECTION.

ONE of the most learned, ingenious, and valuable of the addresses delivered before the late International Congress, says the *Medical Bulletin*, was that of Prof. Bouchard, of Paris. Of the eight different processes by which it has been thought that the animal tissues were able to protect themselves against the action of bacteria he dwelt upon but two as being efficient, viz., phagocytism and what he has denominated the bactericidal condition. In the former cellular activity prevents the development of micro-organism; in the latter a chemical condition is induced, which not only destroys the microbes, but retards their growth and multiplication, reduces their nutrition, and weakens their functions. Phagocytism is a general and universal process, a constant function during health. The bactericidal condition is accessory and contingent. Neither, taken by itself, is capable of preserving or restoring the integrity of the economy. It is, in general, by the concourse and association of the two processes that immunity is assured and cure produced. In vertebrate animals local injury excites an accumulation of those cells capable of migration—the white blood corpuscles and the leucocytes of the lymph. By the side of this pathological diapedesis of white blood cells there is constantly taking place a normal migration of lymph cells toward the surface of the internal integument. This occurs especially in those places where microbes are able to penetrate an intact membrane, as in the pulmonary alveoli, the tonsils, and Peyer's patches. Now, even in health microbes do succeed in passing these boundaries, but they are immediately destroyed by the lymph cells. Hence, although these organisms abound in the respiratory and digestive tracts, they are, in normal conditions, prevented from entering the blood. The normal blood, as Pasteur has asserted, contains no bacteria, but Professor Bouchard has seen them rapidly make their appearance in the blood of healthy animals when those are exposed to the action of causes which induce the development of infectious disease in man.

The prolonged action of a moderate degree of cold is one of the commonest of these causes, and in animals subjected to such influences for a few hours the presence of bacteria in their blood could be demonstrated by culture. It follows that inhibitory nervous influences embarrass normal phagocytism. A temporary suspension is followed by the passage of microphytes from the lung, pharynx, or intestine into the blood. In a corresponding manner the same influences restrain the pathological phagocytism with which the white blood corpuscles are concerned. Phagocytism, consequently, whether under normal or pathological conditions, is one of the manifestations of *vis medicatrix naturæ.*

Very slight differences of chemical composition of inert media suffice to render the growth of microbes more or less active. This consideration helps us to comprehend that differences in the consumption of the humors of living animals may produce the same results. Thus, for purely chemical reasons, bacteria may be destroyed, dissolved, or inhibited in development. On the other hand, their activity may be greatly heightened, while between these two extremes every grade of variation may occur. A certain number of these results have been obtained by the culture of pathogenic bacteria in animal fluids which have been entirely free from cells. It has been observed that the blood of an animal naturally resistent to a certain microbe may, nevertheless, serve as an excellent culture medium for that very microbe. Moreover, the blood of an animal which is unresistent to a certain microbe may prove destructive to that microbe.

These paradoxical facts prove that natural immunity does not depend upon the bactericidal condition, and that receptivity is not linked with the absence of that condition. It is with acquired immunity that the bactericidal condition is concerned. An infectious malady, when not fatal, produces at the same time immunity and a durable modification of the fluids, which it renders bactericidal, that is, capable of producing, if cultivated, an attenuation of a microbe of the same species which gave rise to the disease. This bactericidal condition does not depend upon the cells which may be present in the fluid. As regards five microbes it has been demonstrated that vaccination produces the bactericidal condition.

Bacteria act upon animals by means of the substances which they secrete. The intensity of the chemical action is proportional to the quantity of chemical substance produced. This quantity may be considerable, owing to the immense rapidity with which bacteria multiply. There are now known eight physiological properties belonging to bacterial products, by which pathogenic microbes can influence animal bodies.

Œdema and suppuration resulting from exudation and diapedesis are the expression of vascular reaction, but this reaction is not, according to Professor Bouchard, the direct result of the chemical action of the bacterial products upon the vessel. It is due to an active vascular dilatation, which places the vessels in the condition studied by Cohnheim as the stage preliminary to diapedesis. In the case of those diseases which develop without any local excitement at the point of introduction, the probable explanation is that their specific microbes secrete irritant matters, but that they also secrete a matter which prevents the occurrence of diapedesis. Such matter acts by paralyzing the vasomotor center. Therefore, while bacteria generate substances capable of producing local irritation,

the vaso-dilator paralysis induced by another secreted product prevents the occurrence of local inflammation, and particularly vascular dilatation, exudation, and diapedesis. For this reason they are unchecked by phagocytism, and left free to develop, multiply, and secrete. In addition, however, to those noxious materials produced by bacteria, others are formed which are useful to the infected system. Such are the vaccine elements of bacterial secretions. The list of these is being constantly enlarged. They are eliminated by the urine, and are not entirely removed prior to the expiration of fourteen days. Their action must necessarily be indirect, because their protective influence does not manifest itself until the fourth day after injection, when a great part of the matter is already eliminated.

The immunity which they confer depends, in fact, upon the production of the bactericidal condition. The condition remains after the substance which produced it has passed out of the system. The nutritive type of the animal cells is definitely changed. Immunity is established somewhat slowly. If, when exposed to infection, the fluids are bactericidal, there is no growth, no development of microbes, and no disease excited. If, on the contrary, the fluids are favorable to growth of the microbe, the development begins immediately, and the phenomena of disease ensue. If there is no irritation at the point of entrance of the germ, the system loses the protective advantage of phagocytism. Fortunately, however, while the bacteria throw deleterious substances into the blood and tissues, they are secreting another substance, the presence of which is not revealed for a certain number of days, but which penetrates the cells, modifies their nutrition, and, in fact, establishes the bactericidal condition. At this instant the disease has attained its acme and begins to decline.

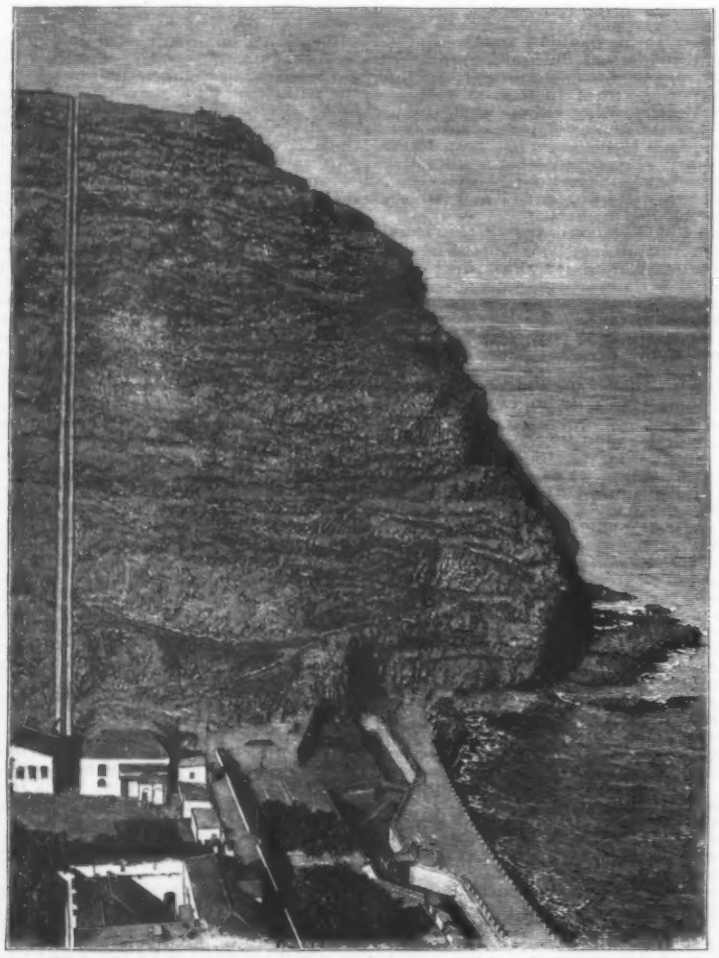
We have thought fit to present to our readers the foregoing abstract of the views of the eminent French professor on account of their scope and ingenuity, and the importance of the subject. As he himself remarked at the termination of his eloquent address, they are doubtless not exempt from hypothesis, but he believes that in essential points they rest upon a firm basis of experimental demonstrations.—*Sanitary News.*

VIEWS IN ST. HELENA.

A SPECIAL interest always attaches to St. Helena, both as being the place of Napoleon's exile and death, as being one of the most isolated islands in the world, and as being (formerly more than now) an important halting station for vessels bound from Europe to the East. Seen from a distance, the island appears to be a gray pyramidal mass, rising abruptly from the ocean, presenting no sign of vegetation, and apparently inaccessible; but when more nearly approached, several openings are discovered, the best of them, in which Jamestown is situated, forming a fine natural harbor. Our engravings are from photographs by Mr. B. Wood, of Jamestown, to whom we are indebted for the following particulars:

Napoleon's Tomb.—It is said to have been Napoleon's own wish that his body should be interred in this quiet and secluded valley, which was accordingly done, and for many years it was his resting place. The body, however, was subsequently removed to France. The vault is inclosed by an iron railing, and is covered by a whitewashed slab. Not a single word remains to tell that it was the grave of Napoleon I.

Ladder Hill, St. Helena.—The quarters of the troops forming our slender garrison are situated at the top of this hill, which rises to a height of about 630 feet above the sea. Here also is the signal station, from which passing ships are spoken, and the time gun, by which all clocks and watches are regulated. The top of the hill may be reached either by the zigzag road of about a mile or the celebrated ladder of 699 steps.



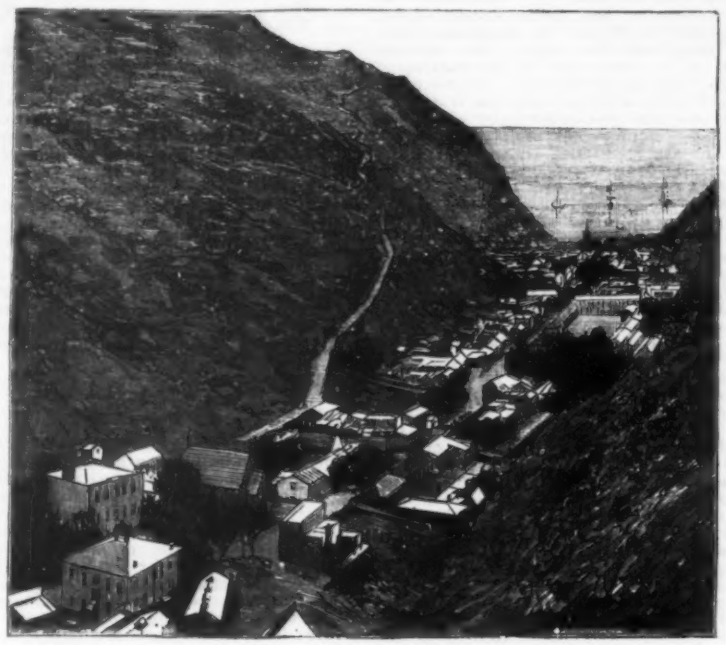
LADDER HILL, ON WHICH IS SITUATED THE GARRISON AND SIGNAL STATION.

Plantation House, the seat of H. E. the Governor, Mr. W. Grey-Wilson, stands in a fine park (about three miles from town), in which are to be found specimens of vegetation from all parts of the world. It is a paradise to the botanists who occasionally pay a visit to this out-of-the-world spot.

Napoleon's House, Longwood.—In this house the first Napoleon spent his exile, and in it he breathed his last. It is the property of the French government, and is beautifully kept by the courteous and kindly guardian of the French property, Mr. Morilleau, whose family are ever ready to welcome visitors, and never tire of answering questions about the great Napoleon.

Rosemary Hall.—The residence of the exiled Zulu chiefs is situated in the best and most fertile part of the island, and the exiles appear to be fairly happy there. They do occasionally, but not often, obtain the governor's permission to leave their prison and visit Jamestown, but on the whole they seem to prefer the seclusion of Rosemary. Their guardian, Mr. Saunders, has just been removed to Natal, and they are not pleased about it.

Jamestown, from Side Path, Looking North.—This view shows nearly the whole of Jamestown, which is situated in a valley running north and south. It is the only town on the island, and contains two Episcopal churches, one Roman Catholic, and one Baptist chapel, civil and military hospitals, lunatic asylum, poorhouse, and a good market, where fresh vegetables can be purchased every morning. The whole town has a dilapidated and poverty-stricken appearance, and as it appears, so it is.—*The Graphic.*



JAMESTOWN, FROM THE SIDE PATH, LOOKING NORTH.

ACTION OF LIGHT ON PHOSPHORUS.

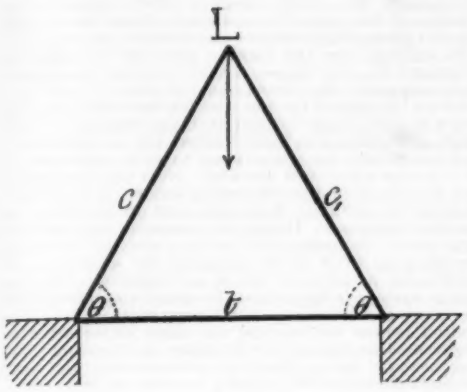
PEDLER has extended to phosphorus his investigations upon the action of light upon chemical substances. A glass tube was filled with a nearly saturated solution of phosphorus in carbon disulphide, sealed and exposed to full sunlight. In a few minutes a yellowish red coating began to form on the sides of the tube, and continued until the interior was covered. After about three weeks' daily exposure to sunlight, the tube was opened and the precipitate examined. After washing with carbon disulphide, a bright red powder was obtained, which under the microscope appeared to be a mixture in about equal parts of bright sulphur-yellow particles and bright red particles. The powder remained unchanged in the air, and was unacted on by water, alcohol, ether, benzene and carbon tetrachloride. A warm dilute solution of sodium hydrate, however, dissolved it readily with evolution of gaseous hydrogen phosphide. On cautious heating, the yellow portion sublimed, leaving the red portion. The sublimate was partially soluble in carbon disulphide, and the solution contained ordinary phosphorus. Moreover, the yellow undissolved portion burned in the air like ordinary phosphorus. Similar experiments were made with other solvents or in vacuo, with similar results. When diffused daylight only was employed, the first precipitate was sulphur-yellow, passing to orange, and, after some months, to a bright red. It was readily dissolved by dilute sodium hydrate solution, on boiling. As the particles of allotropic phosphorus grow larger, they appear to deepen in color. Formed at high temperatures, the precipitate is darker in color. Comparing this product with commercial red phosphorus, and with the so-called metallic or rhombohedral phosphorus, the author concludes that the term "amorphous" is misleading, since the great bulk of the powder thus designated consists of transparent ruby-red, more or less crystalline particles which polarize light. By elutriation, it can be separated into a very fine red powder, and into almost black shining particles which, under the microscope, are crystalline and transparent, transmitting a ruby-red light. Both are acted on by sodium hydrate solution, the action being greater as the particles are finer. Moreover, on heating the red phosphorus to 305°–310° for two hours, or even to 326° or 357°, no sign of any change could be detected in it. But at 445°, the temperature of boiling sulphur, a certain amount of vapor was produced which was oxidized on contact with the air. In vacuo, about one-fifth of the red phosphorus sublimed as ordinary phosphorus into the upper and cooler portions of the tube, when heated at 445°. The author believes, therefore, that no change takes place in red phosphorus below 358°, and that even up to 445° it is exceedingly slow. Experiments upon the permanency of this variety of phosphorus in the open air showed that so far from being the inert and stable substance it is usually supposed to be, it is prone to change, being easily oxidized even in the air, and readily deoxidizing phosphoric acid. The so-called metallic phosphorus, prepared either by dissolving ordinary phosphorus in lead at high temperatures, or better by projecting red phosphorus on the surface of melted lead, and then removing the lead with nitric acid, was obtained as a crystalline powder consisting of rhombohedrons, some darker and some lighter in color than the ordinary red phosphorus. This variety of phosphorus polarizes light in the same manner, is acted upon similarly with sodium hydrate, and behaves in a similar manner

when heated. Hence the author concludes that the metallic and the red are the same allotropic form of phosphorus, and recommends that the term "amorphous" be discarded.—*J. Chem. Soc.*

THE ECONOMICAL ANGLE.

By FREDERIC R. HONEY, Ph.B., Yale University.

IN designing a structure of the form of the accompanying figure, which shall be capable of sustaining at its apex any load L, it is desirable to determine a formula which will give the angle θ contained between the elements c, c_1, which are in compression, and the element t, which is in tension. This angle, which may be termed the *economical angle*, should evidently be of such a value that the total weight of the structure, including the three elements c, c_1 and t, will be as small as possible. Since the proportion between the tensile and crushing strength of materials varies very widely, the



value of θ should correspond to the material employed. It is proposed to make θ dependent upon the crushing strength (= C) and the tensile strength (= T).

Let W = weight of structure.
Let L = load.
Let w = weight per cubic inch of material.
Let t = length of element t in inches.

$\therefore$ Length of elements $c + c_1 = t \sec\theta$

$$\text{Tension in element } t = \frac{L}{2}\cot\theta$$

Compression in each of the elements c and c_1 =

$$\frac{L}{2}\operatorname{cosec}\theta$$

Number of square inches in section area of element

$$t = \frac{\frac{L}{2}\cot\theta}{T}$$

Number of square inches in section area of each of the elements c and c_1 = $\dfrac{\frac{L}{2}\operatorname{cosec}\theta}{C}$

Weight of element t = length × section area × weight of cubic inch of material = $t \times \dfrac{\frac{L}{2}\cot\theta}{T} \times w$

Similarly, weight of elements $c + c_1$ =

$$t\sec\theta \times \frac{\frac{L}{2}\operatorname{cosec}\theta}{C} \times w$$

The weight of the structure W will be equal to the sum of the weights of the elements t, c and c_1 and may now be expressed in terms of the variable angle θ.

Thus

$$W = t \times \frac{\frac{L}{2}\cot\theta}{T} \times w + t\sec\theta \times \frac{\frac{L}{2}\operatorname{cosec}\theta}{C} \times w$$

$$= t \times \frac{L}{2} w \left(\frac{\sec\theta\operatorname{cosec}\theta}{C} + \frac{\cot\theta}{T}\right)$$

It is required to make W a minimum.

Differentiating

$$\frac{d.\,W}{d.\,\theta} = t\frac{L}{2}w$$

$$\left(\frac{\sec\theta\operatorname{cosec}\theta\tan\theta - \sec\theta\operatorname{cosec}\theta\cot\theta}{C} - \frac{\operatorname{cosec}^2\theta}{T}\right)$$

Putting $\dfrac{d.\,W}{d.\,\theta} = 0$

We have

$$t\frac{L}{2}w\left(\frac{\sec\theta\operatorname{cosec}\theta\tan\theta - \sec\theta\operatorname{cosec}\theta\cot\theta}{C} - \frac{\operatorname{cosec}^2\theta}{T}\right) = 0$$

or, dividing by $t\dfrac{L}{2}w\operatorname{cosec}\theta$, and transposing,

$$\frac{\sec\theta\tan\theta - \sec\theta\cot\theta}{C} = \frac{\operatorname{cosec}\theta}{T}$$

Dividing by $\sec\theta$

$$\frac{\tan\theta - \cot\theta}{C} = \frac{\cot\theta}{T}$$

$$\therefore T\tan\theta - T\cot\theta = C\cot\theta$$

Dividing by $\cot\theta$

$$T\tan^2\theta - T = C$$

$$\therefore \tan^2\theta = \frac{C+T}{T}$$

$$\therefore \tan\theta = \sqrt{\frac{C+T}{T}}$$

The resistance to crushing and tensile strains as a mean gives for cast iron C = 4·3 T; for wrought iron C = 1·5 T.

Substituting these values in the formula

$$\tan\theta = \sqrt{\frac{C+T}{T}}$$

For cast iron, $\theta = 66{\cdot}5°$

For wrought iron, $\theta = 57{\cdot}7°$

AMBROSE GODFREY'S FIRE EXTINGUISHER.

IN 1723 Ambrose Godfrey brought to perfection his invention for extinguishing fires, and in his patent, which is dated November 12, 1723, it is described as "consisting of divers casks and other vessels and materials for the extinguishing of fires in houses and ships of which he hath made two publick experiments with good success." The first of these experiments was tried in the presence of the Lord Chancellor, Sir Hans Sloane, Sir George Beaumont, Sir J. Thornhill, and other distinguished persons, in Belsize park on April 2, 1723. "A wooden house, three stories high, having been erected for the purpose, with the addition of shavings, brushes, faggots, pitch, oil, etc., to increase the fury of the flames, which were suffered to rise to their utmost height. Then a machine was flung into the ground apartment, which instantly extinguished the fire there."

The second experiment was tried in Westminster fields on May 30, when a fire lighted in a house of three stories was extinguished in three minutes. These experiments were described in a pamphlet published in 1724, entitled "An Account of the New Method of Extinguishing Fires by Explosion and Suffocation," in which Godfrey complains of Charles Povey's behavior to him, Povey being the proprietor of Belsize house and a rival inventor. On the title page is this reference to the patent taken out in the previous year: "A method easily practicable, certain in its effects, and so universally useful to the public, that his majesty has been moved to authorize and encourage this happy discovery, for the general advantage of his subjects, by his most gracious letters patent."

The following description of the apparatus is given by the inventor: "The new method I have to offer to the publick consists of gunpowder closely confined, which as soon as animated by fire acts by its elastic force upon a proper medium (water impregnated with a certain preparation) and divideth it instantly into millions of millions of most minute and imperceptible atoms, which with equal violence and swiftness are immediately forced into the innermost recesses of the flames." Further on we are told that "the constituent parts of the machines are the shell and the powder magazine. The shell is a small wooden barrel with wooden hoops: in the middle of the top an opening is left for the fuzee to pass through. This barrel is cased without and well lined within, the better to hold the liquid, which is a mixture which never corrupts or alters, when on the contrary mere water would soon putrefy and stink. The powder magazine is a vesica of a spheroidal figure, either of pewter or some other lasting substance, filled with gunpowder, having on one end a pipe, which pierces the top of the shell in the middle, and serves to guide the fuzee to the main magazine. This powder magazine is fixed in the center of the shell, incompassed with the above mentioned liquid. The fuzee is garnished with wild fire, secured with a tin cover lined, to be taken off when the machine is to be used."

The prices of the machines were, first size, £1 5s.; second size, £1 1s.; third size, 18s. The chimney shells: first size, 10s. 6d.; second size, 7s. 6d. They are sold at "Mr. William Briggs, joiner, over against Salisbury Street, in the Strand."

These small kegs appear to have been used for a time with success, as the following notice from *Bradley's Weekly Messenger* of November 7, 1727, seems to show: "Last Sunday . . . a fire broke out at the Crown Tavern, in King Street, near Guildhall. The same morning, I am informed, two other fires occurred, but I have not heard the particulars. In some of these, however, I hear that the famous machines, or fire watches, invented by Mr. Godfrey, the great chymist, in Southampton Street, Covent Garden, display'd their wonderful effects, and prevented the progress of that furious element; with what quiet and satisfaction may we not therefore live when we have the advantage of such safeguards."

The inventor died on January 15, 1741, and his pamphlet was reprinted in 1743 and 1744; but little more is heard of the fire annihilator until September 1760, when the inventor's son Ambrose Godfrey (the second) wrote to the Society of Arts, "giving an account of the success of his family's invention for the extinguishing of fires." This letter was considered by a committee, and arrangements were made for testing the invention. A Mr. Keys was engaged to erect a building in the Marylebone fields which could be experimented upon. The date and hour were fixed, but great fears were entertained in respect to the conduct of the mob that was likely to be attracted by the exhibition. The secretary was "ordered to write to the printers of the several newspapers printed and circulated within the bills of mortality, that it is the request of the Society that if they should hear of the day appointed for the experiment for extinguishing fires, they will not insert the day in their papers." Application was made to the authorities for a guard of 200 men, and a civil magistrate was requested to attend. The experiment was successful, and gratuities were given to the guard and to the peace officers. The cost of building the house was £54 1s.

The following description of the proceeding is taken from a contemporary number of the *Gentleman's Magazine* (vol. xxxi., p. 236): "May 19, 1761, Mr. Godfrey's experiment for extinguishing fire was tried in the house erected for the purpose, by the Society of Arts, etc., in Marylebone fields. The Duke of York, Prince William and Prince Henry, several persons of distinction, and a numerous crowd attended on this occasion. The house, which is of brick, consists of three rooms, one above another, a staircase, chimney, lath and plaster ceilings, and a kind of wainscoting round the rooms, of rough deal. At twelve o'clock the ground room and that up one pair of stairs were set on fire by lighting faggots and shavings laid there for that purpose. In about fifteen minutes three of the machines were thrown into the under room (the wainscot of which was then in flames), which by their explosion immediately extinguished the fire, and even the smoke soon disappeared. The like experiment was next tried with the same success on the middle room, the staircase by that time having taken fire, and lastly, to remove all doubt (the populace beginning to be dissatisfied, and to talk of a second bottle conjuror), Mr. Godfrey consented to a third experiment in the upper room, which was entirely of wood. The flames were now suffered to get to a considerable height, and even the window frames destroyed before the machines were thrown in, which, however, answered exactly as before. One hundred and forty of the foot guards attended on this occasion."
—*Journal of the Society of Arts.*

[CONTINUED FROM SUPPLEMENT, No. 708, PAGE 12233.]

FABRICATION OF TWELVE-INCH MORTARS.

By A. A. FULLER and F. N. CONNET.

IN the July *Indicator* may be found a description of the casting and hooping of 12 in. B. L. R. mortars. The next step in construction is the fine boring, which is accomplished by a succession of reamers used with a special lubricant, which insures the hole to be the exact size of the reamer. The final bore must be between 12·000 in. and 12·008 in. diameter, and straight enough to allow a test cylinder 11·997 in. diameter and 42 in. long to slip through easily.

Fig. 1 is diagramatic only, and shows the principal parts of the boring and rifling machine. In boring and reaming, the tools are keyed to the end of the boring bar, B B, the gun revolves, and a slow feed is given the bar by a small spur pinion meshing with spur teeth cut on the external face of the friction drum, F. This drum is keyed to the screw, S, which runs in a circular cut inserted into the worm wheel, W W, and attached to the boring bar.

Next comes the rifling. Few operations in machine shop practice require as much care as the rifling of a cannon, since so much is at stake. There is no part of the most expensive steam engine but can be replaced in case of an accident during the manufacture, but here the result of months of labor may be entirely spoiled by a false cut. The body would be ruined and the steel hoops encircling it would be worthless. The necessity for extra care both in the design and operation of the rifling machine is apparent. Among the mechanical safeguards is an electrical contrivance for stopping the machine instantly. A lever with an armature attached holds the mechanism in running order as long as the closed circuit is on the electro-magnet coils attracting this armature. It is then a comparatively simple matter to provide a number of contrivances to short-circuit the current at the operator's will, or automatically, the moment any detail gets out of alignment.

In rifling, the tool is held in the rifling head, R H, attached to the boring bar, B B, and a backward and

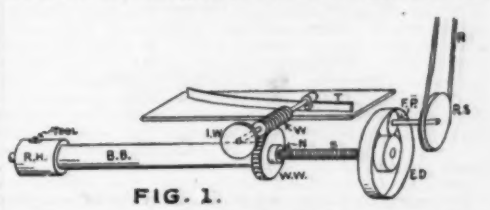


FIG. 1.

forward motion is given it by the rapid revolution of the regular feed screw. A combined internal and external friction gear, F, is placed on the end of this screw, and between the two parts of this gear the friction pinion, P, driven by a rope belt, R, revolves constantly in the same direction. When this pinion is brought into mesh with the large internal gear a comparatively slow motion is given the boring bar in the cutting direction. When brought into mesh with the small external gear, a quick return is obtained. The working is quite noiseless, and the reversal takes place within more narrow limits than is usually accomplished on a planer. On the end of the boring bar is keyed a worm wheel, W W, and the worm, W, engaging therein is long, allowing it to be used both as a worm and as a rack. It is used in the former capacity when indexing the bar and tool from groove to groove, and in the latter capacity when giving the rotary movement to the bar, which combines with the longitudinal movement to form the helical grooves. The frame holding the worm has an arm, at the end of which are two small rollers, one running on each side of a flat track, bent in a horizontal plane to a curve, which is the de-

velopment of the helical grooves in the gun. When the boring bar moves longitudinally, the rollers running upon the track give a transverse movement to the worm, thus rotating the bar the proper amount for every foot of advance. The track is a flat piece of planed steel, and can be bent by screws and clamps to the required curve. In these mortars an "increase pitch" is used, varying from one turn in 25 calibers to one in 40, the curve being a semi-cubic parabola; 68 grooves are cut 0·379 in. wide and 0·07 in. deep. The object of the "increase pitch" is to avoid a too sudden initial rotation of the shot when fired. On smaller and less expensive ordnance the uniform pitch is still retained, and its manufacture is easier, since the rotation of the rifling bar can be effected by gearing instead of some form of cam. The rifling head R H, or arrangement for carrying the tool, is keyed on the end of the boring bar, and contains a wedge to which motion is imparted by a buffer at each end of the stroke. The movement of this wedge sets the tool out at the beginning of the cutting stroke and withdraws it at the end. This head being furnished with slightly compressible wooden lags, entirely fills the bore, and at the same time does not mar its surface. The depth of cut is adjusted by a nut that governs the amount of movement of the sliding wedge, and as the movement of the wedge is much greater than that of the tool, it is possible to obtain a very fine adjustment of the tool. The limit allowed on the depth of each groove is 0·0015 in. The removal of the chips is accomplished by a series of steel scrapers, which push the chips out at each end of the bore.

The next operation is the threading, which is done with an attachment on this same machine. To insure a thread of exactly the same pitch as that on the breech block the lead screw, C, Fig. 2, is cut on the same lathe as the breech block itself. The nut, A, is made to take up wear, and is fastened in the tapering part of the bore directly in front of the threaded recess. This lead screw has a head or enlargement at the back end, with a device for holding and feeding the cutting tool, T, radially. This head is also keyed into the boring bar. The nut, N, Fig. 1, is detached from the bar, which does not revolve while the tool is cutting. The nut, A, Fig. 2, revolves with the gun, pulling the feed screw

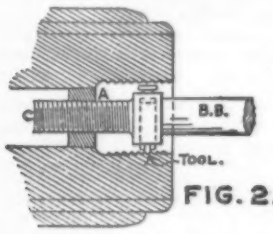


FIG. 2.

tool and boring bar along at the proper speed to give the correct pitch to the threading. To run the tool back the gun is stopped, and the bar is rapidly revolved by means of a rope belt driving the worm, W.

In slotting out the interruptions in this threading the nut, N, Fig. 1, is replaced in position, and the boring bar is given its planer-like motion the same as in rifling, but with short stroke. A small shaper head with apron is keyed into the bar for this process, and the whole machine becomes a large shaper. A toothed wheel, with pawl and lever, are placed on the worm shaft and give a circular feed to the bar and shaping head.

The longitudinal reciprocating motion of the bar is also employed in lapping or smoothing the bore with emery embedded in a cylinder of soft metal.

The hinge block, H B, Fig. 4, and segment, S, are mortised into the breech end of the mortar. These mortises being quite irregular in form, their manufacture is often conducted by drilling, chipping and filing, a difficult and unsatisfactory method when interchangeability is desired. A special milling machine, Fig. 3, was therefore constructed, resembling somewhat a horizontal radial drill.

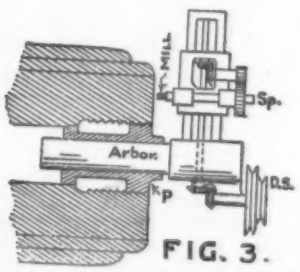


FIG. 3.

The machine is centered and held in the bore of the mortar by the plug, P. The spindle, Sp, is capable of two movements, one of rotation about, the other radial to, the axis of the mortar; a combination of these two movements giving, of course, any desired movement to the milling cutter. The spindle and milling cutter are guided along their proper path by a templet or profile plate bolted against the mortar. Drills are afterward substituted in the place of the milling cutter, and the necessary bolt holes are drilled and tapped. The whole apparatus is portable, and is driven by a rope belt after the manner of the various small drilling machines now on the market.

Fig. 4 shows a rear elevation and a central longitudinal section of the breech-loading mechanism for these mortars. The breech block, and the recess into which it locks are cut with a thread of 0·9 in. pitch; these threads are then interrupted or planed off longitudinally in three places, each 60 deg. wide. This allows the block to be shoved into the recess its whole length, then, when turned 60 degrees, the remaining thread on the block and in the recess mesh with each other, locking the block in position.

The face plate, F P, is a banjo-shaped piece, dovetailed to the breech block, and turns it in and out of mesh with the interrupted thread by means of the crank, C, and the gear running in the circular rack or segments, S. The tray, of composition metal, is swung to the breech face of the mortar by means of a vertical pin passing through two lugs or projections on the hinge block, H B. The latch, L, holds the tray against the breech face of the mortar, and the securing latch, S L, holds it when swung back out of the way for loading. T R is the translating roller which moves the breech block in and out of the breech recess, by means of a stud attached to the face plate and running in the left hand groove cut in the roller. The roller has also a right hand thread, and travels in the tray as a nut. The spindle, Sp, is fitted

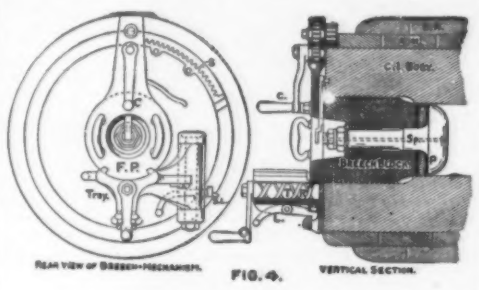


FIG. 4.

loosely in the center of the breech block, and has a 0·2 in. hole drilled through its entire length. The primers are inserted in this hole and the charge exploded thereby. Behind the mushroom-shaped head of the spindle are two steel gas check cups which inclose the gas check packing, P. When the mortar is fired this packing is squeezed out against the sides of the bore between these cups, preventing the escape of the gases in a backward direction. The face plate is inclined toward the right when the breech is locked.

To load, unlock, by turning the crank, C, to the right, bringing the face plate as shown. A stud on its lower face comes into the left hand thread of the translating roller. This roller is next rotated, pulling out the breech block, spindle and face plate on to the tray. The latch is now released and the tray and contents swung around out of the way. The shot is now raised by a sort of crane and shoved in. Next follows the powder in a canvas bag. The tray with contents is swung back to its first position. The breech block is run in by turning the translating roller crank handle, and locked by the revolving gear handle. This uncovers the vent, where a primer is inserted, and the mortar is ready to aim and fire.

At this point it may be of interest to make a comparison between the Krupp system of breech loading for heavy ordnance and that of DeBange. In the Krupp system the breech is closed by a cylindrical block or wedge, W, Fig. 5, sliding in a cylindrical opening of

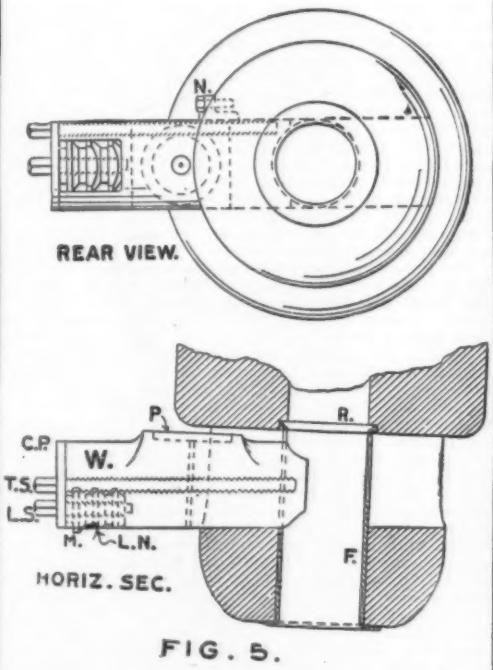


FIG. 5.

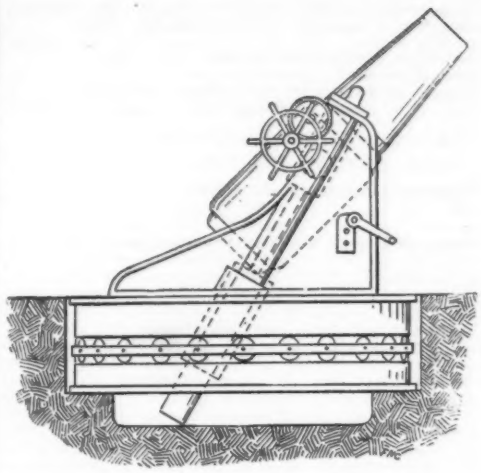
the same shape, whose axis makes an angle slightly less than 90 degrees with the longitudinal axis of the gun. This cylindrical block is flattened on its forward side to a plane, making a slight angle with the axis of the block, and a right angle with the axis of the gun, thus forming a wedge one side of which is cylindrical. When the wedge slides in and out it is guided by its cylindrical surface, and held from turning by a spline way and key; the front plane surface therefore takes a series of positions all parallel to each other, and approaches and recedes from the corresponding plane surface of the cylindrical opening in which the wedge slides.

Near the center of the plane surface of the wedge is inserted a disk, forming the gas check plate, P, and in the plane surface of the opening, and concentric with the bore, is a gas check ring, R; these two come in contact when the block is screwed "home" into firing position, and are supposed to stop the entrance of gases to any other part of the breech mechanism. In heavy ordnance the wedge is moved in and out by means of a traversing screw, T S, running in a nut, N, attached to the body of the gun. O is a cap plate screwed to the back end of the wedge. The wedge is locked into position by means of the screw, L S, and its nut, L N. The locking screw bears at one end in the cap plate, in which it is held by collar and shoulder, the other end of the screw has a bearing in the wedge itself. The screw has no movement of translation. The nut, L N, is situated in a recess cut in the wedge, and has a slight motion of translation and a motion of rotation for one-third of a turn. Its rotation is stopped at the proper point by a stud on its exterior. The nut, L N, has circular grooves cut on its exterior, forming circular teeth and spaces. With the exception of one tooth, M, nearest the cap plate, the portions of these teeth which protrude above the surface of the wedge, when the nut is in its unlocked position, are planed off flush with the exterior of the wedge, allowing it unimpeded entrance into the opening. When the nut is turned the portions of the teeth before in the recess of the wedge engage in notches cut in the side of the opening to receive these teeth, and locks the wedge and gas check to correct position before firing.

To lock, slide the wedge into the opening by means of the traversing screw. Next turn the locking screw; the nut first moves along the screw until its teeth come opposite to the spaces in the sides of the opening; the nut then turns with the screw, its teeth meshing with the spaces. The word "Locked" then shows cut in the face of the nut. The screw is further turned until the cap plate of the wedge bears against the nut.

To unlock, turn the locking screw in the opposite direction; the nut ceases contact with the cap plate, then turns with the screw, and the word "Open" appears on the face of the nut; by further turning of the screw the nut moves inward until the whole thread, M, bears against the gun itself, holding the nut stationary and compelling the wedge itself to move outward until it brings up against the nut. Next pull the wedge out by means of the traversing screw. Krupp's mechanism is certainly ingenious, and in practice it is said to work well. It may be somewhat slow to operate, but it is impossible to blow out the wedge or breech plug even if left unlocked by accident, and safeguards in time of battle are valuable. The De Bange system is being tried by many countries, while Germany and Russia use the Krupp mechanism. The United States are making all large ordnance with slight modification of the DeBange mechanism. The gas-checking device seems to be successful, and fully protects the rest of the breech mechanism from corrosion.

In these mortars about 70 pounds of powder will produce an initial pressure of some 28,000 pounds per



square inch, and give a muzzle velocity of 1,200 feet per second to a shell of 650 pounds. This will insure a range of about six miles at 45 degrees elevation. The hollow cast iron shot is filled with a mild form of nitroglycerine. Its front end is turned to a curve called the "ogival," which form offers least resistance to the air; its back end contains a soft metal collar, which, when forced into the rifling grooves, gives it the required rotary motion. The ingenious primer, which fires the explosive, is also placed at the back end of the shell. Its action depends upon the inertia of a little mass that does not move from its place when the shot is fired, but is projected forward against a fulminating cap when an object is struck. In other words, it is active during a minus and not a plus acceleration of the shot.

These mortars are to be mounted on carriages very similar to cannon carriages, except that the recoil takes place 60 degrees from, instead of in, the horizontal plane. This allows of a reduction in length of the carriage, and the set of rolls used for revolving about a vertical axis is continued around a complete circle, instead of relying on a small arc, as is frequently done.

It might seem strange to some that cast iron is used for the mortar bodies instead of steel, but even the advocates of the latter do not claim great advantage in guns of such short bore. The casting of large masses of steel seems to be attended with so many difficulties, and, what is of more importance, with so many uncertainties, that the ordnance department prefers good iron to doubtful steel. These mortars very closely resemble the steel breech-loading rifles made by the United States Navy department, with the exception of their length, which in rifles is about thirty times the diameter of the bore, and in the mortars only about ten.

It is proposed to distribute over 1,000 of these mortars along our seaboard, in groups of sixteen, to have them below the surface of the ground, and to fire them simultaneously by means of electricity, and it is not improbable that the latter agent will also be used for aiming purposes, after the manner recommended by Lieutenant Bradley Fisk. When one considers the number, the reliability, the range, the capacity, and the great accuracy of aim obtainable in these mortars, some of the fears he may have entertained about the safety of our country from external foes should be dispelled. An opinion expressed by Lieutenant William R. Hamilton, in the *Century Magazine* for October, 1888, is shared by many ordnance experts. It is that this design of mortar has no superior the world over.—*Stevens Indicator.*

IS THE AIR NAVIGABLE?

BRIEFLY but emphatically I say, "Yes!" and by the following most simple means: Imagine the whole top of accompanying diagram, down to the point F, to be of one rigid piece. If it were then to float in space, the fin like sail, D, would cause the balloon, A, to face the wind at A. This being made clear, it follows that additional length of the balloon would not increase resistance to the wind, plainly demonstrating that one hundred tons of weight can be carried just as easily as even half a ton, as far as the balloon is concerned. The swivel, F, permits the swinging around in every direction of the compass of the passenger car, G, by means of fanwheel, H, and rudder, J. The swiftly revolving fanwheel imparts velocity to both car and the passive balloon overhead; the latter so contrived, as shown, as to make it utterly impossible for it ever to get athwart the wind. Inside of A, a smaller balloon, N, is connected through pipe, M, with an air pump on board the passenger car. Pumping air into the smaller balloon forces the gas out of the larger, and bringing it down through pipe, K, renders it available as fuel to generate motive power. One pound of ballast thrown overboard will enable the use of thirty cubic feet of gas, or if the balloon, A, is large enough to carry an excess of two hundred pounds of ballast, two hundred and fifteen cubic yards of gas may be consumed as fuel without loss of buoyancy. Every available power may be applied. Hand power, even, is adequate. Electric motors, gas or petroleum engines can also be so adapted as to render service as motors in an air ship.

Should the invention be introduced, it will revolutionize the present order of things on the habitable globe, and call for the immediate investment of more than four times the capital now invested in railroads and telegraphs put together. Two hundred miles an hour will not begin to touch the limit of speed. This is my firm conviction, and I declare, by the eternal verities of cause and effect, that the results, as described, will be as sure as the law of gravitation. All willing to assist in the experiment are cordially welcomed to a share of the emoluments and glory. I both invite and challenge expert criticism.

N. HELMER, Inventor,
129 Fourth Ave., New York.

HELMER'S SYSTEM FOR AERIAL NAVIGATION.

SOME RECENT CONSTRUCTION OF RAILWAY BRIDGES.*

By JAMES RITCHIE, Member of Civil Engineers' Club of Cleveland.

SINCE the first of the present year the writer has had many opportunities of comparing the recently constructed bridges of the different railroads of the country.

Beginning with the Southern roads, a noticeable increase in the construction of iron bridges shows that the tendency toward the most permanent and substantial work has taken firm hold upon the management of Southern roads. The Norfolk and Western R.R. has been building a large number of long and short span bridges, both on its main line and its Western extension. The largest of these bridges is that across the Ohio River at Ceredo, W. Va., which is known as the "Ceredo" bridge. This bridge consists of one channel span of 518 feet, two spans of 298 feet, and a series of approach spans. The total weight of this structure complete will be 3,250 tons.

The main line bridges and the bridges of the Western extension are largely plate girders. All of the above are being built at Edgemoor.

The Louisville and Nashville R.R. have recently let contracts for about 2,000 tons of bridge work, distributed among the various bridge works of the East and at the Louisville, Mt. Vernon and Shiffler bridge works, west of the Alleghanies. The Nashville, Chattanooga & St. Louis R.R. has also placed several bridges and shop roofs at the Louisville bridge works, aggregating about 400 tons.

The East Tennessee, Virginia & Georgia R.R. have recently erected the Ocmulgee River drawbridge, of 212 feet span, the Florence drawbridge, several smaller bridges across the bayous and creeks of Alabama, and have placed with the Louisville Bridge Co. two 182 feet draw spans for Ocmulgee River.

The Georgia, Carolina & Northern Ry. have completed several 200 and 150 feet span bridges and have two others under construction, and the contracts let for two long bridges, one being over the Savannah River.

The Georgia Central Ry. and the Atlanta & West Point Ry. are having several bridges built also, and the Queen & Crescent route are improving their line in the same manner.

In the West and Southwest the building of bridges is also being rapidly extended. The Union Bridge Co. is building ten spans for the Missouri, Kansas & Texas, the Ft. Smith bridge for the Missouri Pacific, and the Memphis bridge across the Mississippi River.

The Chicago Forge and Bolt Co. has built and just completed this year a large number of plate girder spans, aggregating about 800 tons, for the St. Louis & San Francisco Ry.

The Phœnixville bridge works is building four bridges, and Detroit has just completed three bridges for the St. Louis, Arkansas & Texas R.R.

In the East and North there is also considerable building and more under contract. The Maine Central has four bridges under way at Union Bridge Co. and one of three spans at Passaic. The New Jersey Steel and Iron Co. has several bridges for the N. Y. C. & H. R. Ry., and is also building the Burlington bridge across the Mississippi River for the C., B. & Q. R.R.

At Elmira bridge works there is being built for the N. Y. Central a plate girder span of 115 feet in length.

Span.	Loading. Engine Consolidation.	Loading. Train Load per foot.	Description of Truss. (All Single Track.)	Weight per foot exclud. ing Ties and Rails.
212		4,000 lb.	Draw span, includ. drum.	1,225 lb.
205	2-104 ton.	3,000 "	Through Pratt.	1,600 "
200	2-85 "	3,000 "	" "	1,277 "
200	2-104 "	3,000 "	" Camel B'k	1,427 "
179'4½"	2-104 "	3,000 "	" Pratt.	1,400 "
179	2-104 ton.	3,000 lb.	Thro' Draw Span.	1,230 lb.
168	2-104 "	3,000 "	" Pratt.	1,210 "
160	2-112 "	4,000 "	Deck "	1,100 "
150	2-104 "	3,000 "	Thro' Camel Back.	1,165 "
148	2-112 "	4,000 "	" Draw Span.	1,122 "
145	2-104 "	3,000 "	Deck Pratt.	904 "
148	2-112 "	4,000 "	" "	1,040 "
150	Train of 110	ton Engines.	Through Pratt.	1,073 "
130	" "	" "	Deck Lattice.	810 "
120	" "	" "	Through Lattice.	1,328 "
148	2-112 ton.	4,000 lb.	Deck Pratt.	1,054 "
104	2-104 "	3,000 "	" "	1,010 "
102'6"	2-104 "	3,000 "	Through Pratt.	1,000 "
90	Train of 110	ton Engines.	Deck Lattice.	805 "
82	2-104 ton.	3,000 lb.	" "	781 "
80	2-112 "	4,000 "	" "	700 "
76		4,200 "	Through Plate.	1,070 "
70	2-104 "	3,000 "	" "	892 "
66	Train of 110	ton Engines.	Deck "	610 "
64'6"	2-104 ton.	3,000 lb.	" "	587 "
65		4,000 "	" "	604 "
55	Train of 110	ton Engines.	Through "	740 "
53	" "	" "	Deck "	641 "
45	" "	" "	" "	626 "
30	" "	" "	" "	475 "

understood by the bridge companies will be the most satisfactory to them as well as to the other parties concerned. They specify everything, are arranged systematically and are not susceptible of being evaded.

The girders, of which there are two, are straight on top and bottom and the web is 108" × ⅜" of iron. The plates are 72" wide, and consequently are placed with the fiber vertical. There are three angles in each flange, two being on the inside of the web and one on the outside. They are 6" × 6" × ¾" in section, and the cover plates of flanges are 24" × ⅝". Also Elmira is building another bridge for N. Y. Central, which has one 95'-4½" span and two 40 feet spans, also of iron.

The Cuyahoga bridge of the Lake Shore Railway is a double track through drawbridge of 305'-10½" span, built of wrought iron with steel eyebars, by the Union Bridge Co., at their Buffalo shops. The total weight of the superstructure is 655,000 lb. in round numbers, and the weight of the turntable, which was built at the Athens shops, is 266,000 lb.

The Ocmulgee River draw, built by the Keystone Bridge Co., is 212 feet span, and weighs complete, including turntable, 359,792 lb. This is a single track through span, and the weights given both in this case and Cuyahoga draw do not include the track or ties, but only the actual bridge and floor system ready for the ties.

The following list of weights per running foot of the superstructure ready for the ties and rails, but not including same, may be of interest to the members of this club. The weights are taken from actual bridges which the writer has personally recorded in the books of the Pittsburg Testing Laboratory.

Many other instances could be cited to illustrate the relation between the weights and spans of different bridges.

Many other bridges than those previously mentioned have been built for the railroads in this section, notably for the Lake Shore, the Michigan Central, N. Y. Central, Pennsylvania, Toledo and Ohio Central, Toledo, Peoria and Western, and Wabash Railway, but time prevents further enumeration.

The writer wishes to comment upon a few of the details of bridge specifications and the material for bridges. Probably the specifications of Mr. Geo. S. Morison, engineer of the Memphis and Burlington bridges, are the most complete, and when thoroughly

When material is specified to be of such a quality and the line is distinctly drawn limiting the same, no deviation from these limits is possible under these specifications, and as soon as the absolute line or a similar one is used by all engineers, just so much easier will it be to obtain satisfactory work. The writer does not mean to imply that any condition should be made which is impossible to comply with, but that the conditions should be such that manufacturers *can* comply with them, and that then no deviation from those conditions should be permitted. The general practice of bridge engineers is tending in this direction, and with improvement in specifications and in their enforcement we shall find corresponding improvement in our engineering structures.

The New York Central Railway, in specifying steel for bridges, now requires only *acid* open hearth steel, not permitting the use of Bessemer steel in any part of a bridge. The Memphis and Burlington bridges above referred to are built almost entirely of *basic* open hearth steel, although acid open hearth steel will also be used in some parts of these bridges.

To many engineers the use of basic open hearth steel is new, and, therefore, they hesitate before specifying it. It has, however, shown, in the material for Memphis bridge, a uniformity in its chemical composition which speaks well for its being used largely in structural work. The percentages of phosphorus, sulphur and silicon have not generally varied over $\frac{1}{10}$ of one per cent. in the different heats. The carbon of course varies according to the grade of the steel (there being three grades, soft, medium and high grade) between $\frac{1}{10}$ to $\frac{1}{4}$ of one per cent., but is very uniform in each grade. For steel plates it is said that this material has given good satisfaction.

It was at first intended to use only Bessemer steel in Memphis bridge; but after making several tests and experiments, the open hearth steel was adopted.

Many bridges are built under Cooper's specifications which are so familiar to all engineers as to need no explanation. The requirements of these specifications as to iron tension members seem to the writer to be too high in the relation of specimen to full size tests.

* Read August 12, 1890.

The requirement of 52,000 lb. ultimate on sections less than 4¼ square inches in specimen test, and 50,000 lb. ultimate in full size test seems to be too small an allowance. In making full size tests of iron eyebars to destruction, the writer has noticed that the bars fail (unless there is some flaw elsewhere) either near one head or the other, indicating that the material has possibly been injured in forging the head. It would perhaps cause the material to return to its original condition to anneal the eyebar in the same way that steel eyebars are annealed. The writer does not know of this having been done in any case, but is of the opinion that a few experiments might be made with satisfactory results. Certainly no injury would be done and much good might be accomplished.

DISCUSSION.

Mr. Osborn: I would suggest that if Mr. Ritchie has an opportunity he revise his paper by adding the loads for which the new bridges are designed, besides the weights given:-that data regarding weights in bridges are certainly very valuable, and the suggestion is made that the list be increased.

Mr. Barber: A short time ago I was investigating the subject somewhat, and found that there seemed to be considerable activity shown in the matter of railroad bridge construction throughout the country. The bridges that were built ten years ago were built for engines and trains of a certain weight, and from that time to the present I think the rolling stock has constantly been increasing in weight. The result has been that almost all the old bridges, even those built within a very few years past, have had to be rebuilt.

Mr. Swasey: I was somewhat interested in the statement made in Mr. Ritchie's paper in regard to the use of plate girders. He mentions one of 108 inches in depth. We see a great many girders of less depth than this, but do not hear of many of this depth.

Mr. Gifford: I recollect the bridge of the New York Central Railroad of which Mr. Ritchie speaks. In this bridge, which I think is the longest plate girder that ever came under my notice, being of 115 feet span, the web is not made of plates 108 inches wide, but of a width of 72 inches, standing on end.

Mr. Reid: [A visitor.] Mr. Barber speaks of the tendency to increase the weight of cars. I have noticed on some roads that where engines, ten or fifteen years ago, weighed but from 35 to 40 tons, now a weight of from 50 to 70 tons is the rule. The Lake Shore road has cars carrying a load of 120,000 pounds of iron ore, this being exclusive of a car weight of 36,000 pounds, and on account of this great increase in weight the company is changing a great many of its bridges.

Mr. Porter: The use of steel seems to be on the increase as applied to railroad bridges, but, in my opinion, iron in a good many places is just as good—perhaps better—and much cheaper on account of ease in working it. My idea is that for bridge work hard steel is not very good, and in certain places in bridges I much prefer a soft steel. Last year the New York Central road used comparatively soft steel in their bridge construction, but my opinion is that we can get nothing to excel iron where there is much abuse shown.

We all know that the engineer of the Board of Commissioners of New York State, Mr. Stowel, is a strong advocate of riveted structures, and the principal reason is, as I understand, that trains can run off the track on the structure and still it does not fall. This, of course, is a little exaggerated. A good many believe in another kind of a structure. There are some cases where riveted work is preferable. The aim, I understand, is to put steel in bridges where it will not be likely to receive sudden blows. When the St. Charles bridge went down, the conductor testified that they were going very slowly. This had a cast iron upper chord, but we don't know that it was the cast iron which first failed.

Mr. Searles: The destruction of one of the spans of the St. Charles bridge was attributed to insufficient flooring, and the derailment of the car or the breaking of an axle drew the floor beams together and left large spaces, which resulted in the destruction of the entire truss, the cars falling into the spaces.

Mr. Porter: A bridge floor should be not only notched down, but thoroughly bolted. Of course, there is a little play, but not much. Ties should be placed eight inches apart, and, sometimes, less.

Mr. Palmer: Probably the chief difference between the plate girder and the truss, in regard to endurance, is that the plate is heavier, it being made entirely of riveted work. In American truss work, bars and pins are largely used, while the English rivet their truss work very much more than we Americans do.

Mr. Baker: Is there any tendency among Europeans to the use of the American pin connected truss? It seems to me that if the American bridges have stood the test of time and usage, they would begin to come into use in the old country among the more prominent engineers.

Mr. Porter: In many cases, for short spans, the road men prefer to use a riveted structure, and many railroad companies specify them. There are certain local circumstances that may change any particular design, but the impression among railroad men is, I believe, that the riveted truss of 74 or 80 feet is much stiffer when the train passes over it than the pin connected truss.

Mr. Biggar: Would not the argument apply to longer spans? You limit it to 80 feet.

Mr. Porter: Some do. Mr. Stowel, of New York, does not limit it, but runs it up to 200, if necessary.

Mr. Swasey: Is it not a fact that greater repairs are required on a riveted than on a pin connected structure? The Sixth Avenue Elevated Railroad, of New York, I think, is a pin connected structure and costs very little for repairs.

Mr. Biggar: From my own experience the repairs are considerably less in riveted work than the pin connection, on an average.

Mr. Rice: I think the common impression among engineers with whom I have talked is that plate girder work has been the most expensive.

Mr. Searles: The European engineers are remarkably conservative as to their designs. I do not know that the American pin system is being used in Europe, but it is in Australia. English railroad managers continue to use small cars. Perhaps it is only in America that we see large cars and prodigious loads. Possibly it is coming to a question as to the weight the rail can stand rather than the bridge, as whatever load comes on the bridge must come through the rail. There is a limit to the crushing qualities of steel if it is soft enough to be safe.

Member: The rivets are being removed from the Victoria bridge, at Montreal, by the bushel every year. They are seen lying upon the ice beneath, during the winter.

Mr. Baker: The amount of strength of a rivet in a given structure is one of the things we cannot find out, because the initial strain upon it after cooling is indeterminate.

Mr. Biggar: The statement just now in regard to the Victoria bridge I do not think is really the fact. It may be as described; of course, the Victoria bridge is constantly undergoing repairs, and the rivets may have dropped on the ice. I think that so far as the Victoria bridge is concerned, it is as good a bridge as any in America. It is a plate girder bridge in which there is a great weight of iron that might have been saved.

Mr. Searles. It is undoubtedly true that a great many rivets used to drop out in the winter time—that is, the heads have dropped off from rivets in many of our riveted bridges.

There are a great many good qualities in rivet work. Probably one reason why rivet work is not more popular may be that the early structures built in the riveted fashion were more or less defective in workmanship, while at the present time, when as much of the work is done at the shop as possible upon riveted structures (the rivets being placed by hydraulic machinery, and the strain accurately adjusted to the size of the structure), the work is more uniform in character. The probability is that modern rivet work will show better results. On the other hand, we know that our pin connected structures are giving excellent service. The failure in either case may be attributed to defective workmanship at the time of construction or insufficient proportioning for modern loads.—*Jour. Asso. Engineering Societies.*

THE ARTS OF THE BLIND.

To no people have the progress and inventions of modern civilization opened up greater possibilities and provided more ameliorating conditions than to the blind. In ancient days the blind boy or girl begged by the wayside. In these latter days the blind boy buys and sells, teaches, tunes pianos, and performs many acts of manual labor, while the blind girl is skilled in the running of the needle, treads her sewing machine, plays her guitar, cooks a dinner, and teaches with success.

There is in New York City a massive gray stone building, set in a green court, just where Thirty-fourth Street crosses Ninth Avenue, presided over by Mr. William B. Wait, where modern science is grappling with the problem with most satisfactory results. Mr. Wait's idea is that the only way in which the blind may approach a minimum of fairness in competition with the seeing is through superior trained intelligence by which to obtain the greatest power of their faculties within the limitations prescribed by blindness. The results obtained by this policy may arouse interest as to the methods by which they are secured, and disabuse some popular fallacies concerning the peculiarities of the blind. One of the students, after leaving the institution, asked for work of the superintendent of a large piano factory.

"But what can you do? You can't see."

"I can tune pianos. You don't tune pianos with your eyes. Try me and see."

The trial was made, and, owing to the rare accuracy and delicacy of perception in a trained ear, the work was done so satisfactorily that a permanent place was secured in the factory. A little later the superintendent of an outside tuning department in connection with the factory was needed. Again the blind man came to the front, saying confidently:

"I can do that. Why don't you try me?"

They did try him, to their perfect satisfaction. He had four seeing men under him, and an immense territory to cover. In going about from place to place he frequently had an opportunity to advise the purchase of a piano, and received a commission from the factory if he accomplished a sale. To-day he is the proprietor of three large music stores.

Two other students of the institution, entering about the same time, are now engaged in prosperous pursuits in a Western city. One was the son of moneyed people, and musical in his tastes, becoming ultimately a fine organist. The other, less gifted, entirely dependent upon himself, engaged in mercantile pursuits. He obtained, in addition to his other business, a contract for carrying the mails, and later applied for a place as tax collector, claiming and exhibiting ability to perform the work. Political parties united in securing his election, and giving, as they said, "the blind fellow a chance." He was married and had paid for a home when he came back to see his friend the musician. The latter, less ambitious, depending on the affectionate care of friends, had made little advance. These friends had died and left him needy and alone. But the mercantile man, having imbibed something of the Western rustle, hurried his friend back with him, sent out of town for some musicians and soloists, organized a concert, and at the appropriate time introduced his blind friend, at whose marvelous skill, faultless technique, and delicate shading the people were astonished. The result was that he was engaged to play in one of the large churches at a generous salary.

It was indeed the blind leading the blind, but neither came to grief.

One of the ex-students is a piano tuner at Steinway's, another a newsdealer in Brooklyn with three places of business, and an income sufficient to support his family in comfort, and still another is a peddler in Ohio, selling valuable goods. He chose the State of Ohio as his field because of its level surface, had a cart of peculiar style constructed, purchased his stock in New York, packed and arranged it carefully in the cart which was being built for him in a little town in this State, and was to be shipped at the builder's expense, and, when it arrived in the Western town, his horses drew it from the station directly out on the first trip with no delay.

Some of the girls have become so proficient at the sewing machine and knitting machine as to be engaged in displaying their work in warerooms; others are successful teachers of music or of literature to the blind; still others are proficient cooks, and, if not able to earn their support in a public way, so helpful and capable in their homes that they can be in no sense considered dependent.

It required three years to teach the first pupil the use of the sewing machine, owing to the lack of experience on the part of the teachers and the lack of confidence in her ability to learn on the part of the pupil, as well as some fear of the machinery, which she could not see. The first disastrous attempts were made with the entire machine. The needles broke and the thread snarled as the wheels were reversed or the work pulled the wrong way. Then better intuitions came and better results followed. First, the treadle was explained and its motion taught with no needle in the bar, and when the foot became so sensitive to its motions as to realize instantly whether the wheel was turning properly and in the right direction, another portion of the machinery was explained and taught in the same way, until finally the blind girl winds her bobbin, puts it in place, and threads the needle quickly in some mysterious way, prepares her work, and stitches so neatly one would scarcely know from the motion of her hands that they were performing the work of eyes as well as hands.

In the same way the knitting machine is taught so thoroughly that in the buzz and whirr of half a dozen machines each girl detects quickly the peculiar click that indicates a dropped stitch on her own work, and with her sensitive fingers finds the wandering thread and loops it over the needles with her crochet hook so deftly that it is hard to believe she does not see either thread or needles.

The use of the typewriter is taught to boys and girls, and it is by means of this they write letters to their friends who can see. They manage the machine entirely, insert the work and prepare it alone. The greatest disadvantage under which they labor, which hinders their writing from dictation as an occupation, is their inability to look back in case of interruption to find the last written word or to correct their work when finished.

Mattress making and repairing is another industry taught, and is under the charge of a man and woman each totally blind. The work, when completed, is purchased by private customers, many of whom have been regular patrons of this department for several years.

The literary and musical teaching of the blind has been greatly simplified by the introduction of the new point system, which Mr. Wait perfected after many years of study and experiment. Not only were the books printed with embossed letters expensive in manufacture, but many pupils of sufficient mental ability to acquire knowledge had not the perceptive, sensitive touch necessary to learn to read them with the fingers. The new system constructs the entire alphabet by the varieties of form which six raised dots arranged in two horizontal rows of three can be made to assume by the omission of one or more of them. This arrangement of letters is governed by the order of recurrence, those letters most frequently used being constructed of the smallest number of dots. Thus *a* is made of two horizontal dots in the upper row—· ·—and *e* of two vertical dots—: —while *b* has four dots—: · ·—etc. The blind write with the dots by laying a paper over a corrugated plate covered with depressions, with which a style is pressed from the other side of the paper in the various arrangements required to form the letters. The dots are kept in position by a movable spaced plate, which fits over the paper and is fastened to the slate by means of pegs, and the writing is done from right to left.

The books printed in this way are large, but not so unwieldy as those printed with letters. A so-called "Brief History of the United States" is nearly as large as an unabridged dictionary, though much less unwieldy and heavy. About 300,000 volumes are in the possession of the institution, and include school books and books of fiction, travel, and history, supplied to the reading rooms, of which there are two, one for boys and another for girls. These reading rooms are fitted up with desks for reading instead of chairs, on account of the difficulty of holding any of the books in the hand or on the knees.

This system of dots, too, is used entirely for the writing and printing of music for the blind. It has been falsely said that the blind print their own books; but it is true that they write much of their own music, for so many signs are used in place of words that the task is less arduous than one might suppose, and can be accomplished as quickly as a sighted person can write notes on the staff. The progress made by the pupils in music, particularly in harmony, seems quite the most remarkable of all their accomplishments. A class of boys and girls averaging fifteen years of age, and containing several pupils much younger than that, will answer questions concerning the construction and combination of chords, laws of rhythm, and counterpoint, and distinguish the difference in major and minor scales by ear with a readiness that would astonish a conservatory graduate. In the music rooms, on either side the long corridors devoted to this art, one may see a blind boy learning his keyboard by practicing hour after hour the striking of the notes or chords, putting his hands in his lap after each note for an instant before he strikes another, so as to learn to touch mechanically and readily any note on the keyboard, to measure distances, and locate chords. In another room a girl is playing a polonaise from Chopin from the notes, not by ear, and playing with exquisite feeling and rare delicacy of touch. At the pipe organ in the chapel a boy sits with his music book on the bench beside him, playing, while another blind boy pumps the organ. Until a piece of music is committed to memory, the pupil touches the dotted characters representing notes with his fingers, carries the entire line in his mind until he can play it, removes his hands from the keyboard to read again, and so continues until the page is completed. From the time the education of the blind began, music has been considered an essential part of the curriculum, and by many believed to be, like mathematics, almost as easily mastered by the blind as by the seeing.

The deprivation of one faculty does not add in any way to one's capability. If the blind have a delicate touch, an accurate ear, a power of concentration of thought, it is not because they are blind, but because ear and hand and reason have been trained by constant practice and effort. There is no natural develop-

ment of these faculties, and no difference in the natural status between the blind and the seeing. In respect to technical execution the blind labor under great disadvantages, but in ear culture and theoretic knowledge the results obtained are exceptional, and many of the totally blind have attained artistic eminence as pianists and organists.

The kindergarten system is used entirely among the smaller pupils, and object teaching follows throughout the whole course of instruction. Every subject is, if possible, reduced to a mental objective attitude in its presentation. Besides the common branches, English history, physiology, with apparatus, rhetoric, algebra, geometry, logic, mental and moral philosophy, science of government, and natural philosophy are all taught.

For one hour each day the entire school of 250 pupils, divided into sixteen divisions, is instructed in free calisthenics outdoors, if the weather will permit, using dumbbells, wands, elastic straps, and rings, or the simple mechanical arrangement of muscles with which nature supplies the blind as well as those not thus afflicted. Owing to their constant apprehension of falling or a collision, the blind suffer much from a lack of physical development and vital energy, and are inclined to assume awkward attitudes in standing or walking, all of which are modified to a marked degree by the introduction of physical training.

The cooking classes are more comprehensively taught than are those in the public schools, as each pupil has a good-sized gas stove, with griddles and an oven, which she is taught to light and care for in every way herself. Each has, too, a small cupboard for her utensils, the arrangement of which shall be according to her fancy, and each is taught by actual practice to cook in a wholesome way the simple dishes most commonly served, to make an appetizing soup out of the bits that are left from a dinner, and to make and bake bread and biscuits entirely without assistance. Only four pupils are taught at one time, and the room in which the work is accomplished is kept in perfect order by the sightless cooks.

Mr. Wait refutes the theory that the blind can distinguish color by touch, according to traditional belief. In his opinion there are some blind people who like to hoax and some sighted people who like to be hoaxed. It is the arrangement of colors which causes them to distinguish them in working, the effect of the dyes upon some materials, such as jute, which some colors soften and others render harsh, that enables them to select them so readily, to the astonishment of the observer. A bit of blue glass and a bit of red glass of the same shape convey the same idea to the touch of one totally blind.

It has been said with some truth that blind people are, as a rule, happy and sunny in youth, but grow morose, complaining, and fretful in later life. The apparent change in disposition is due to the constant suffering endured by many blind, to the weariness arising from a lack of occupation, and many times to the fancied neglect of friends, rather than to the simple fact of their being blind. Parents and friends through sympathy frequently render a blind person exacting, helpless, and unreasonable by mistaken though loving service. When the parent dies or becomes enfeebled by advancing years, the blind person fancies in the unavoidable change in service indications of neglect and lack of affection. Those blind people who have become self-reliant and accomplished in any art or industry retain their cheerfulness as long as they do their usefulness. It is difficult to determine which branch of study is most easily and pleasantly pursued by the blind, but it is safe to say that spelling is quite as difficult to acquire as any, owing to the fact that the words can never be impressed on the mind by constant reading and writing, as with sighted people, but must be mastered each one by itself by a mighty effort of the memory.

Complex, indeed, is the task of educating one who is blind, even with the improved modern apparatus, for blind children are not, as a rule, put into school until later than sighted children; have a more delicate physique, and are unable to do the same amount of mental work; are removed from school while still young through the mistaken kindness of friends, or perhaps on account of weakness or disease, and they must learn in this limited time a greater amount than children who can see. To a child who has seen an object, the word representing it conveys a decided impression; the child who cannot see must spend much time in acquiring a knowledge of the object before the word can be presented.

So in music the sighted child learns to play on the keyboard, which he sees; the blind child must learn laboriously the form of the keyboard before he can touch the notes. A greater amount of effort must, therefore, be put forth on the part of both pupil and instructor to obtain anything like the varied practical results which are now accomplished in the instruction of those who walk in darkness.—*N. Y. Sun.*

A NEW STAND.

THE preliminary report of the committee on "composing rooms and press rooms, with reference to cleanliness and expedition of business," appointed at the third annual convention of the United Typothetæ of America, was read at the late meeting in Boston. The report contained among its many important suggestions a description of a new type stand. Through the courtesy of the *American Bookmaker* we are allowed to take extracts from this particular part of the report and, also, show the stand open and closed.

This form of stand is the result of attempts to overcome certain difficulties encountered in trying to compose the Century Dictionary. For this work the compositor was required to have before him or readily accessible:

Brevier, upper and lower, 2 cases.
Brevier italic, 1 cap case.
Accents for brevier, 1 cap case.
Brevier antique, for side heads, 1 job case.
Nonpareil, upper and lower, 2 cases.
Nonpareil italic, 1 cap case.
Accents, etc., for nonpareil, 1 cap case.
Nonpareil antique, for sub-heads, 1 job case.

The copy called for changes of cases so often that it was not practical to have one or even a dozen common cases of antique or italic. Compositors working from common cases would interfere with each other; they would have to impatiently wait their turns; there would be just complaint at probable bad distribution, for which no one could be held responsible. It was decided that every compositor should have his own set of separate cases. Greek and Heorew, rarely used, were to be the only cases in common. This decision made a new difficulty. Ten exposed cases would fill two sides of an alley. The space occupied by a double alley would take a great deal of room.

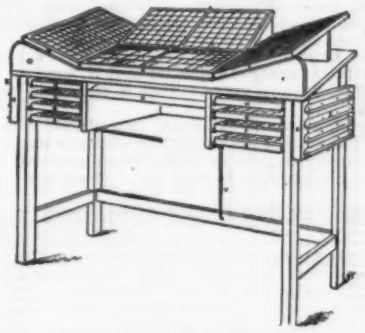


DIAGRAM 1.—CLOSED.

DIAGRAM 1.—A new form of composing stand, which permits the compositor to have ready access to more than eight hundred boxes. This diagram shows the cases in rack, out of use, with swinging side frame put back.

DIAGRAMS 1 AND 2.—A and B, cases for extra sorts; C, nonpareil accents; D, nonpareil antique; E, brevier antique; F, nonpareil Roman upper; G, nonpareil Roman lower; H, nonpareil italic; K and L, brevier Roman, upper and lower; M, brevier accents; I, brevier italic; N, drawer, containing galley; O and P, angled support for cases; R and S, swinging frame with racks; T and U, iron rods that hold the swinging side frame.

The first step was to select the "Rooker" case, 14×28 inches, smaller than the regular case, but large enough for a day's work on the sizes of brevier and nonpareil. The next was to put two more Rooker cases at right angles on either side, tilted upward as shown in the diagrams. The compositor, who stands before the case in the usual position, can readily reach all the boxes of the four cases, except those in the extreme outermost corners. A long-armed compositor can reach all without even swaying his body. This arrangement provides for the brevier upper and lower in the usual position (K and L in the diagram), with the accents to the extreme left (M) and the italic to the extreme right (I).

The framework of the stand below the extreme right and left was utilized by constructing racks with cleats, so that the cases least used could be put in sidewise, and yet be kept within easy reach. A swinging side frame, firmly hinged, was then attached on either side, with cleats parallel to those in the stand. This side frame is kept firmly in position by the swinging iron bar, T. When this bar is locked the cases in either side can be drawn out at full length, exposing every box to view and touch. The compositor is in the center of three sides of a small square, and can pick out any type he wants from about eight hundred boxes, without leaving his frame, and for most of them without change of position. When the lower cases in the side racks are not needed, the swinging side frame can be put back, as shown in Diagram 1. To prevent the cluttering up of stands, and to save needless travel, the galley is put on an inclined plane in a drawer under the Roman case. When the compositor wishes to empty his stick he pulls out the drawer, empties his stick and then shoves in the drawer. It is entirely out of the way, and not as liable to accident as in the old position on an exposed stand.

Two of the job cases have been arranged for capitals to the left and two with capitals to the right. This is to keep the most used division of lower case nearest to reach on right and left hand sides.

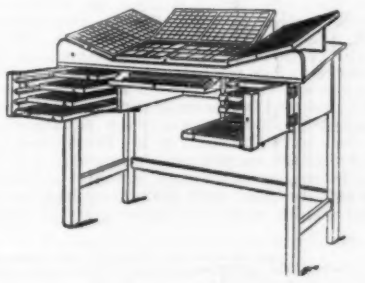


DIAGRAM 2.—OPEN.

DIAGRAM 2.—This diagram shows the swinging side frames drawn out and locked, the under cases made accessible to the compositor, and the position of the galley under the frame.

The Roman cases have all the spaces and the en quadrats directly under the compositor's hand. This arrangement is made by putting the en quadrat next to the three-to-em space box on the other side of the broad bar, and by putting the four and five-to-em space and hair space next to the three-to-em space box. Not many other boxes have to be disturbed to so place these spaces. This arrangement saves time in spacing; it is an aid to better work and is much approved by all compositors. The cost of these stands and cases is not much more than those of the old form. That they are much more economical in saving space and in giving greater ease in the management of work will be admitted by every one who sees them. Thirty compositors work in better light more pleasantly and profitably to themselves and more efficiently for the office in a space of 1,000 square feet than they could do in 2 500 square feet from cases laid out on the old plan.—*Art Printer.*

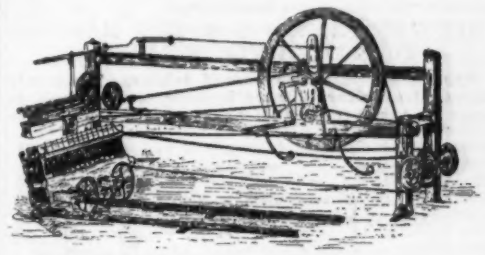
THE HISTORY OF THE COTTON SPINNING MULE AND ITS INVENTOR.

By AUG. STADLER, *in Leipziger Monatschrift fur Textil-Industrie. Translated for the Industrial Record.*

THE working of raw cotton in England commenced about 1641. The fiber was received in London at that time from Cyprus and Smyrna, and shipped to the different manufacturing centers of Lancashire, especially Manchester, where it was principally manufactured into cotton flannel, which was again shipped to London, save the small quantity of it which was exported. Fifty years later (1691) attempts were made in London to manufacture weaves from the raw cotton of the same quality as those imported from Asia. For this purpose a London merchant, John Barkstead, took out a patent for the term of fourteen years, for the manufacture of calico, muslin, and other finer grades of cotton fabric. It cannot now be ascertained whether the patent was of any benefit in improving the quality of spinning and weaving, but it is known that the quantity of the imported cotton amounted to a little less than 715,000 pounds.*

In 1738, Lewis Paul obtained a patent "to make, use, exercise, and vend a newly invented machine or engine for the spinning of wool and cotton in a manner entirely new;"† and, again, twenty years later (1758) a second patent for the same machine was issued to him, which was tried for more than twenty-five years in Birmingham and Northampton, by wealthy, intelligent, and influential men. In spite of this, the results from it were very unfavorable, and it caused the ruin of many persons who had hoped to earn fame and fortune with the machine. The cotton imported in 1764 amounted to 3,870,300 pounds. About 1767, Hargreaves, a weaver of Blackburn, invented the jenny, and Highs & Kay, of Bury, invented the drawing frame. Richard Arkwright, a barber in Bolton, united the two important inventions in one machine, the "water frame." More than 4,000,000 pounds of cotton were imported during that year, and in 1780 it had increased to 6,766,613 pounds. Crompton's mule was delivered to the public in 1780, whereby the importation of cotton in 1789 had risen to 32,288,186 pounds, or, in other words, during the period from 1771 to 1781 the importation of cotton had increased 76 per cent., and from 1781 to 1791, 320 per cent.

Without intending to undervalue the importance of



CROMPTON'S MULE IN CHADWICK'S MUSEUM, IN BOLTON.

the many other inventions, it can be truthfully said that Crompton's invention has proved to be the most valuable "gold mine" the English nation has ever possessed. Samuel Crompton was born at Bolton on December 3, 1753, and during boyhood had to assist his father in spinning and weaving, but at the same time he received what, for that period, was a very superior education, embracing geometry and mathematics. He lost his father at an early age, and then assisted his mother in earning a livelihood, both by spinning and weaving and the sale of fruit and honey, which they produced upon their small grounds called Hall-in-the-wood. Samuel Crompton was at this time spinning with Hargreaves' jenny with 8 spindles; but the yarn was soft, and did not possess the necessary firmness for warp yarns. In 1774 Crompton began his experiments, which resulted in the invention of the "mule," or "self-actor." Little is known at the present time of the different stages of his experiments, until the machine, the principle of which is still the same, stood ready for the market. The greater part of the machine was of wood, rudely cut out with a miserable set of tools, which had been used by his father for making musical instruments. The little smithy is still existing in Bolton where he occasionally tempered and ground his few rude implements.

Mr. John Hennedy, of Manchester, gives a short description of this period in his lecture entitled "A Short History of Samuel Crompton and his Mule," delivered in the year 1830 before the Literary and Philosophical Society. We learn from this lecture that the machine was called the "Hall-in-the-wood-wheel," or "muslin wheel," as yarn for the manufacture of muslin could be spun on it. Finally, it was named the "mule," because it united the two main principles of Arkwright's machine and Hargreaves' jenny. It was Crompton's first idea to construct a pair of rollers or cylinders, which, as he presumed, would "draw" and "stretch" the thread by a pressure similar to that of metal presses. After various unsuccessful trials, he adopted a second pair of rollers of slower revolution than the first, and obtained thereby a draught of from 3 to 4 inches. He finally inserted brass wire teeth in the lower cylinder (being of wood), which then became the fluted roller, but the greatest and most important part of Crompton's invention was the movable spindle carriage and the principle of spinning the thread without tension. The spindle carriage could be pushed back with the hand and knee, just at the time when the cylinders ceased furnishing thread, after which the ready thread could be wound upon the spindles. This was the corner stone of the merits of his invention.‡

In 1779, just at the time when Samuel Crompton had his first mule with 20 spindles ready, there was an uprising among the weavers and spinners of Blackburn, who eyed these new spinning and weaving machines

* Baine's History of Cotton Manufacture.

† Patent list, Bolton Free Library.

‡ "Paper for private circulation only," Manchester, 1830.

with jealousy, which they regarded as calculated to deprive many families of support. They drove Hargreaves out of the city and country, and destroyed every jenny for many miles around Blackburn which had more than 20 spindles. Crompton considered it best to take his machine apart and hide the pieces in the garret of his house, where they remained for many weeks, but were put together again in the course of the same year, and yarn of extraordinary fineness for muslin was spun upon the machine. At this time, Crompton received a gift of honor, a silver watch, which he afterward wore constantly, and which is at present in the possession of Samuel Crompton, Esq., of Cavendish Place, Manchester, grandson of the inventor, who naturally values it very highly. The watch was made by a Bolton watch maker, for the price of five guineas, whose shop Crompton had often visited to watch him at his work.

On February 16, 1780, Crompton married Miss Mary Pimlot, and went to reside with his mother in the Hall-in-the-wood, near Bolton, where he then occupied himself more assiduously than ever with his mule, and astonished the whole manufacturing world by the fineness of his yarn, which, until then, no one had ever been able to produce. The new wheel produced this hitherto unattained success, and promised the inventor both fame and fortune. Possessor of this invention and its secret, blessed with a beloved wife, young, vigorous, and gifted with a spirit of high and well-founded expectations, the future of his life promised to be all he desired. But trouble was in store for him. Crompton was but twenty-seven years old when he invented the machine which was destined to revolutionize the whole course of cotton manufacture. Every expert recognized its merits by seeing the yarn spun with it, and hailed with pleasure the so-long-expected time that a yarn should be spun in England which, when manufactured into calico, would rival that until now imported from East India. Assisted by his wife, he spun with the greatest diligence small quantities of this yarn, constantly improving the quality of the yarn and obtaining higher prices for it from week to week. For his first production of his machine he received 14 shillings per pound for No. 40; shortly afterward, 25 shillings for No. 60; he then spun a small quantity of No. 80, in order to show that it was not impossible (as had been asserted) to spin such high counts upon his machine, and for it obtained 42 shillings.

[RURAL NEW-YORKER.]

IMPROVED PROCESS FOR THE MANUFACTURE OF MAPLE MOLASSES.

AMONG the various articles of table use commonly esteemed as luxuries, there is none, perhaps, held in more universal favor than good, old fashioned maple

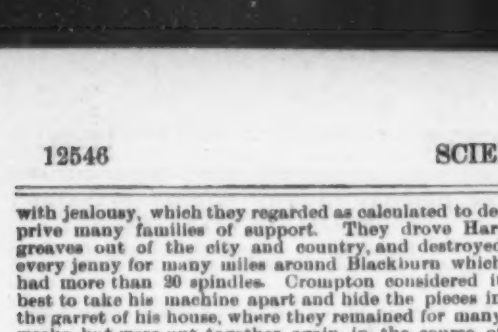


FIG. 1.—MAPLE MOLASSES BOILER.

molasses, pure and unadulterated, such as was made by our grandfathers, and is still made by many small establishments throughout the country. As offered to the consumer at present, most maple molasses is little better than corn sirup, flavored with a small proportion of the genuine article, and, in fact, the genuine sort is rarely found in the market. It is a home manufacture for home use, frequently produced by the rudest apparatus and the simplest process.

Millions of gallons of excellent maple molasses have been made in this way, in iron kettles hung over an open fire, or in the more common sheet iron pan, with its furnace of rough stone. But these methods have their disadvantages. Boiling in a kettle is necessarily a slow process, while the more rapid evaporation in a shallow pan increases the liability of producing a scorched and discolored article, even when the greatest care is exercised. Either method consumes a vast quantity of fuel in proportion to the actual heat utilized, but while fuel was abundant this was no serious objection. Now that maple molasses is an esteemed luxury rather than a necessity, as in former times, and commands a much higher price in the market, the consumer expects nothing less than a strictly first class article in return for his money, and can hardly be induced to purchase anything else. Every improvement in the method of manufacture should therefore be regarded with favor by the producer. Economy in the use of fuel is absolutely necessary in many parts of the country, and any improvement in this direction will prove most beneficial.

Directly in this line are the efforts of a neighbor of mine who, several years ago, devised an apparatus which has proved decidedly successful in every way. The device is not patented, may be constructed and used by any one, and as it possesses more than ordinary merit, I deem it simple justice to make it known to the public. Drawings have been made which, with the accompanying description, it is hoped may impart a thorough knowledge of its construction and method of operation.

Fig. 1 shows the apparatus in its most complete form. The reservoir, A, to hold the daily gathering of sap, may be made of any desired size, this being determined by the quantity of sap it must hold. It should be constructed of two-inch poplar plank, the sides and bottom neatly rabbeted together, with grooves cut across to receive the end pieces, and every joint carefully leaded to make it perfectly tight. A portion of this reservoir is permanently covered, and on this part is constructed a box strainer, S, an opening covered with fine wire cloth, or a square of muslin tacked on top of the box and hanging down inside. The remainder of the reservoir is covered with a close fitting lid to exclude dust and dirt.

The boiling vat, C, is of the same material and constructed in the same manner as the reservoir. It should be 10 to 12 inches deep, and 16 or 18 inches wide, inside measure, and may be eight or ten feet long, or even longer where a large quantity of sap is to be evaporated daily. On the floor of this vat a number of galvanized iron pipes, three-fourths of an inch thick, are laid parallel and made continuous by semicircular "turns" at each end, Fig. 2. These pipes must be *even* in number, making their entrance and exit at the same end of the vat. Quarter "turns" connect the two outside pipes with the upright pipes, M and N, each of which is furnished with a valve. This is shown in the plan at Fig. 2.

The boiling is done by steam introduced into these pipes. The pipe, M, is connected with the steam dome of an ordinary engine or with a steam generator made expressly for cooking, boiling, etc. Open the valve in

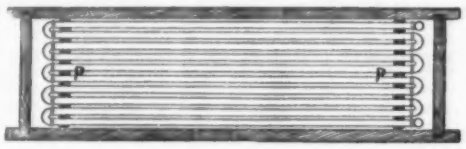


FIG. 2.—THE PIPES.

this pipe, and the steam traverses the pipes in the vat, escaping through the pipe, N, in which it is returned over the side of the vat, and is discharged into the trough, D, where, as it comes in contact with the cold air, a large portion is condensed and carried to a pail or other vessel set for that purpose. The partially heated water thus collected may be injected into the boiler again, and thus saving of heat be made. To prevent loss of heat by contact with the floor of the vat, the pipes are supported a half inch above it by two cross pieces, P and P, as shown in the plan at Fig. 3, and in section at Fig. 4. These pieces are made as follows: A piece of wood one and a quarter inch square is perforated with a line of holes of the proper size and at the proper distances from each other to receive the pipes. This is sawed lengthwise through the centers of the holes, and the flat side of each of these pieces is covered with a strip of iron one-fourth of an inch thick, turned up at the ends for several inches and then bent inward, forming a small hook.

The reservoir, A, is elevated several feet above the ground and communicates with the boiling vat through a large-sized faucet or piece of pipe with a stop cock. One end of the boiling vat is permanently covered to a distance of five or six inches, and through this the

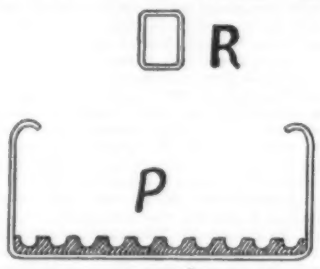


FIG. 3.—CROSS SECTION.

pipes, M and N, pass, fitting loosely in holes cut for them. The remainder of the vat is covered with a lid having strips or "battens" across to prevent warping from the action of the steam. Ordinarily this lid is thrown back while evaporation is going on, but if out of doors it is partially closed during high wind. For this purpose a strap or chain, fastened to the front of the lid, is hung on a hook on the reservoir above.

When the day's boiling is done, the farther end of the vat is lowered by removing the two-inch piece of wood, E, lying on the foundation beneath. To remove the strain on the pipes and at the same time to allow the molasses to flow unobstructed to that end of the vat, the pipes are raised by means of square iron rings, R, Fig. 3, inserted in the small hooks on the supporting cross-piece, P, and hung on a square stick laid across the top of the vat, Fig. 4. The molasses is then removed through an ordinary faucet at F. If boiling the sap in contact with wood is found objectionable, the vat may be lined with galvanized iron, but in this case the joining with the faucet must be made per-

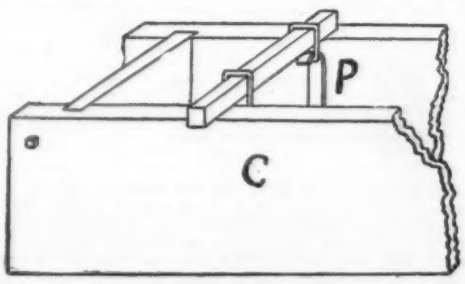


FIG. 4.—RAISING PIPES.

fectly tight to prevent the sap from getting between the lining and the wood.

When the season's work is over, the pipes are removed from the vat, taken apart, washed, and thoroughly dried. They may be oiled and then stored away where they will keep perfectly dry. To remove them unscrew the collar, G, on the pipe, M. A piece of iron, H, bolted to the end of the reservoir supports the upper part of the pipe, and the lower part is unscrewed from the pipes in the vat. The outer portion of the pipe, N, is raised and the entire pipe removed by unscrewing as in the former case. The pipes in the vat are removed together, being lifted out by the hooks on their supports, P and P.

The only disadvantage thus far experienced is the first cost. This is necessarily large. My neighbor has a 10 horse power portable engine which he owned previously, but a much smaller engine will serve the purpose equally well and with less expense. A steam generator, as advertised in some of our agricultural papers, will cost still less. Galvanized pipes and lining for the vat are expensive; but will last for years if proper care is given them.

The quality of the molasses produced in this way, especially when the vat is lined, is all that could be desired. It is almost impossible to overheat it. The heat is under absolute control, and may be completely shut off at any moment by means of the valve in the pipe (M), a thing which cannot be done with a furnace and pan.

Economy in the use of fuel is one of the greatest merits. Even with his 10 horse engine my neighbor asserts that the consumption of fuel is not more than one-third of the amount formerly used in a furnace. A further economy in the utilization of the heat is secured by a valve in the exit pipe (N), which may be partially closed, thus retaining the steam in the pipes of the vat until its heat is fully absorbed in the evaporation of the sap.

To sum up, we have the greatest economy in fuel, perfect regulation of heat, and the certainty of producing a first class article, to offset the extra cost of the plant, which is in reality little more than the cost of the best evaporators now in use. S. P. SHULL.

Montgomery County, Ohio.

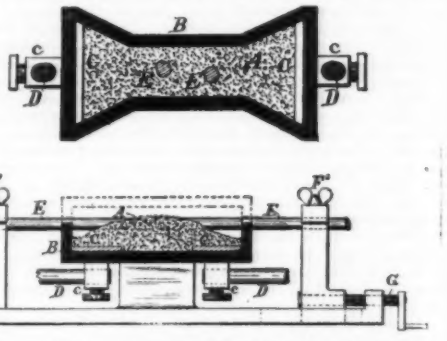
ELECTRIC WELDING.

A RECENT improvement by Mark W. Dewey, of Syracuse, is as follows:

A represents a yielding bed of suitable conducting or semi-conducting material, as powdered or granulated carbon, coal, or metal, or metal mixed with carbon or other semi or non conducting material, as fire-brick, sand, or pumice stone, to obtain the resistance required.

The said bed is preferably supported in a box, B, of non-conducting material, as fire-brick or asbestos. Within and at each end of the box and facing each other are conducting plates, C C, of metal or other material, which form the terminals of an electric circuit and between which the yielding bed is located. Extending from the plates, C C, and through the brick are binding posts, *c c*, to which the electric conductors, D D, leading from a suitable source of electricity are connected.

E E E indicate the bars or blanks of various shapes



and sizes, with their ends embedded in the yielding material to be heated preparatory to being worked or treated, as desired.

In order to prevent the plates, C C, from becoming highly heated, the yielding bed or resisting material is so formed as to be of higher conductivity where it is in contact with the plates, or its cross section at the plates is larger than its cross section in the middle where it is heated and the work embedded.

To locate the heat produced by the current passing through the low conducting material more particularly at the center of the box and not at its ends, without making the surface of the yielding material lower in the middle, I form a box, as shown in the upper cut, with ends of much greater cross section than the middle.

The apparatus described is arranged and supported between a stationary and a movable clamp, similar to those usually employed in electric welding to hold the bars to be welded, to illustrate that bars or blanks can be held in a suitable position to be welded or worked while heated by my method, and after they are sufficiently heated or softened they can be welded or worked in any desired manner before being removed from the box.

The lower figure shows bars, E E, held by clamps, F and F', with their ends in contact and embedded in the yielding material, A, and in position to be welded. After said bars are softened sufficiently the weld may be effected by moving clamp, F', by means of the screw, G, toward the other clamp, after which the bars may be removed.

It will be obvious that should it be necessary to cool the work more or less before removing it from the apparatus, it may be done by discontinuing the current.

With this apparatus bars of very different conductivity and cross section can be united with ease and without burning the smaller bar, as the larger one may be exposed or embedded a longer time than the smaller one.

The plates, C C, lie flat upon the bottom of the box and the yielding material is piled up in the center of the box, leaving the ends uncovered to permit the bars to be passed through easily.

In order to increase the resistance of the yielding material at the joint, a block of non-conducting material, as fire-brick, may be placed between the plates upon the bottom of the box, as shown in dotted lines in the figure.

For the purpose of restoring or retaining the heat, a

cover of non-heat-conducting material may be placed over the box, B, as shown in dotted lines.

It will be obvious that the yielding bed may be of any suitable material that will give the desired resistance to the current and in which material to be worked can be embedded, and may be a liquid, as oil or a metallic liquid.

[Continued from SUPPLEMENT, No. 784, page 12294.]

THE ELECTROMAGNET.*

By Professor SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

II.

THE calculation of magnetic reluctances of definite portions of a given material are now comparatively easy, and, thanks to the formulæ of Professor Forbes, it is now possible in certain cases to estimate leakages. Of these methods of calculation an abstract will be given in the appendix to this lecture. I have, however, found Forbes' rules, which were intended to aid the design of dynamo machines, not very convenient for the common cases of electromagnets, and have therefore cast about to discover some more apposite mode of calculation. To predetermine the probable percentage of leakage one must first distinguish between those magnetic lines which go usefully through the armature (and help to pull it) and those which go astray through the surrounding air and are wasted, so far as any pull is concerned. Having set up this distinction, one then needs to know the relative magnetic conductance, or *permeance*, along the path of the useful lines and that along the innumerable paths of the wasted lines of the stray field. For (as every electrician accustomed to the problems of shunt circuits will recognize) the quantity of lines that go respectively along the useful and wasteful paths will be directly proportional to the conductances (or permeances) along those paths, or will be inversely proportional to the respective resistances along those paths. It is customary in electromagnetic calculations to employ a certain coefficient of allowance for leakage, the symbol for which is v, such that when we know the number of magnetic lines that are wanted to go through the armature we must allow for v times as many in the magnet core. Now, if u represents permeance along the useful path, and w the permeance of all the waste paths along the stray field, the total flux will be to the useful flux as $u + w$ is to u. Hence the coefficient of allowance for leakage v is equal to $u + w$ divided by u. The only real difficulty is to calculate u and w. In general u is easily calculated. It is the reciprocal of the sum of all the magnetic reluctances along the useful path from pole to pole. In the case of the electromagnet used in the experiments last described, the magnetic reluctances along the useful path are three in number, that of the iron of the armature and those of the two air gaps. The following formula is applicable

$$\text{reluctance} = \frac{l_1}{A_1\mu_1} + \frac{2l_2}{A_2}$$

if the data are specified in centimeter measure, the suffixes 1 and 2 relating respectively to the iron and to the air.

If the data are specified in inch measures, the formula becomes

$$\text{reluctance} = 0{\cdot}3132\left\{\frac{l'_1}{A'_1\mu_1} + \frac{2l'_2}{A'_2}\right\}$$

But it is not so easy to calculate the reluctance (or its reciprocal, the permeance) for the waste lines of the stray field, because the paths of the magnetic lines spread out so extraordinarily and bend round in curves from pole to pole.

Fig. 45 gives a very fair representation of the spreading of the lines of the stray field that leaks across between the two limbs of a horse-shoe electromagnet

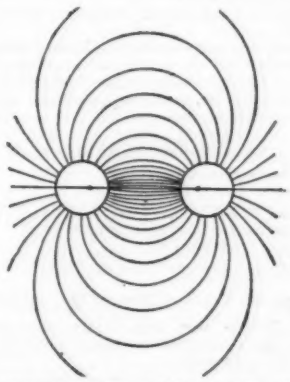


FIG. 45.—CURVES OF FLOW OF MAGNETIC LINES IN AIR FROM ONE CYLINDRICAL POLE TO ANOTHER.

made of round iron. And for square iron the flow is much the same, except that it is concentrated a little by the corners of the metal. Forbes' rules do not help us here. We want a new mode of considering the subject.

The problems of flow, whether of heat, electricity, or of magnetism, in space of three dimensions, are not among the most easy of geometrical exercises. However, some of them have been worked out, and may be made applicable to our present need. Consider, for example, the electrical problem of finding the resistance which an indefinitely extended liquid (say a solution of sulphate of copper of given density) offers when acting as a conductor of electric currents flowing across between two indefinitely long parallel cylinders of copper.

Fig. 45 may be regarded as representing a transverse section of such an arrangement, the sweeping curves representing lines of flow of current. In a simple case like this it is possible to find an accurate expression for the resistance (or for the conductance) of a layer or stratum of unit thickness. It depends on the diameters of the cylinders, on their distance apart, and on the specific conductivity of the medium. It is not by any means proportional to the distance between them, being, in fact, almost independent of the distance, if that is greater than twenty times the perimeter of either cylinder. Neither is it even approximately proportional to the perimeter of the cylinders, except in those cases when the shortest distance between them is less than a tenth part of the perimeter of either.

The resistance, for unit length of the cylinders, is, in fact, calculated out by the rather complex formula:

$$R = \frac{1}{\pi\mu} \text{ log. nat. } h$$

Where

$$h = \frac{2a}{b + 2a - \sqrt{b^2 + 4ab}}$$

the symbol, a, standing for the radius of the cylinder, b, for the shortest distance separating them, μ, for the permeability, or in the electric case the specific conductivity of the medium.

Now, I happened to notice, as a matter that greatly simplifies the calculation, that if we confine our attention to a transverse layer of the medium of given thickness, the resistance between the two bits of the cylinders in that layer depends on the ratio of the shortest distance separating them to their periphery, and is independent of the absolute size of the system. If you have the two cylinders an inch round, and an inch between them, then the resistance of the slab of medium (of given thickness) in which they lie will be the same as if they were a foot round and a foot apart.

Now, that simplifies matters very much, and thanks to my friend and former chief assistant, Dr. R. Mullineux Walmsley, who devoted himself to this troublesome calculation, I am able to give you, in tabular form, the magnetic resistances within the limits of proportion that are likely to occur.

The numbers from columns one and two of the following table are plotted out graphically in Fig.

TABLE VIII.—MAGNETIC RELUCTANCE OF AIR BETWEEN TWO PARALLEL CYLINDRICAL LIMBS OF IRON.

$\frac{b}{p}$ Ratio of least distance apart to perimeter.	Magnetic reluctance in C.G.S. units = the magneto-motive force ÷ total magnetic flux.		Magnetic reluctance in inch units = the ampere-turns ÷ the total magnetic flux. Slab = 1 inch thick.	
	Reluctance.	Permeance.	Reluctance.	Permeance.
0·1	0·2461	4·063	0·0771	12·968
0·2	0·3404	2·938	0·1066	9·377
0·3	0·4084	2·449	0·1280	7·815
0·4	0·4628	2·161	0·1450	6·897
0·5	0·5084	1·967	0·1593	6·278
0·6	0·5479	1·825	0·1717	5·823
0·8	0·6140	1·629	0·1924	5·198
1·0	0·6681	1·497	0·2093	4·777
1·2	0·7144	1·400	0·2238	4·571
1·4	0·7550	1·324	0·2365	4·228
1·6	0·7903	1·265	0·2476	4·039
1·8	0·8220	1·217	0·2575	3·883
2·0	0·8511	1·202	0·2667	3·750
4·0	1·0500	0·952	0·3·90	3·042
6·0	1·1710	0·854	0·3669	2·726
8·0	1·2624	0·792	0·3955	2·528
10·0	1·3350	0·755	0·4131	2·409

NOTE.—In the above table, unit length of cylinders is assumed (1 centimeter in columns 2 and 3; 1 inch in columns 4 and 5), the flow of magnetic lines being reckoned as in a slab of infinite extent, and of unit thickness. Symbols: p = perimeter of cylinder; b = shortest distance between cylinders. In columns 2 and 3 the unit reluctance is that of a centimeter cube of air. In columns 4 and 5 the unit reluctance is so chosen (as in the rest of these lectures wherever such measures are used) that the reduction of ampere turns to magneto-motive force by multiplying by

$$4\pi \div 10$$

is avoided. This will make the reluctance of the inch cube of air equal to

$$10 \div 4\pi \div 2{\cdot}54 = 0{\cdot}3132,$$

and its permeance as 3·1931.

46 for more convenient reference. As an example of the use of the table we will take the following:

Example.—Find the magnetic reluctance and permeance between two parallel iron cores of one inch diameter and nine inches long, the least distance between them being $2\frac{3}{4}$ inches. Here

$$b = 2{\cdot}375\,;\; p = 3{\cdot}1416\; b \div p = 0{\cdot}756.$$

Reference to the table shows (by interpolation) that the reluctance and permeance for unit thickness of slab are repectively 0·188 and 5·336. For nine inches thickness they will therefore be 0·021 and 48·02 respectively.

When the permeance across between the two limbs is thus approximately calculable, the waste flux across the space is estimated by multiplying the permeance so found by the average value of the difference of magnetic potential between the two limbs. And this, if the yoke which unites the limbs at their lower end is of good solid iron, and if the parallel cores offer little magnetic reluctance as compared with the reluctance of the useful paths, or of that of the stray field, may be simply taken as half the ampere turns (or, if centimeter measures are used, multiply by 1·2566).

The method here employed in estimating the reluctance of the waste field is, of course, only an approximation, for it assumes that the leakage takes place only in the planes of the slabs considered. As a matter of fact there is always some leakage out of the planes of the slabs. The reluctance is always, therefore, somewhat less, and the real permeance somewhat greater, than that calculated from Table VIII.

For the electromagnets used in ordinary telegraph instruments the ratio of b to p is not usually very different from unity, so that for them the permeance across from limb to limb per inch length of core is not very far from 5·0, or nearly twice the permeance of an inch cube of air.

We are now in a position to see the reason for a curious statement of Count Du Moncel which for long puzzled me. He states that he found, using distance apart of one millimeter, that the attraction of a two-

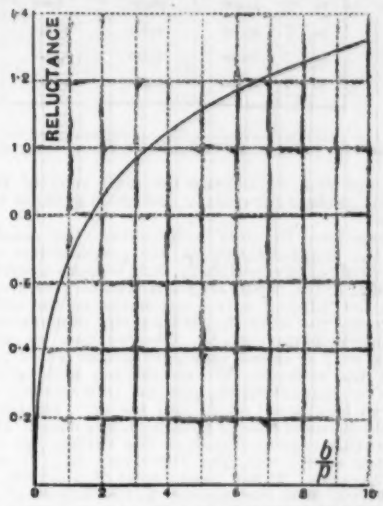


FIG. 46.—DIAGRAM OF LEAKAGE RELUCTANCES.

pole electromagnet for its armature was less when the armature was presented laterally than when it was placed in front of the pole ends, in the ratio of 19 to 31. He does not specify in the passage referred to what was the shape of either the armature or the cores.

If we assume that he was referring to an electromagnet with cores of the usual sort—round iron with flat ends, presumably like Fig. 11—then it is evident that the air gaps, when the armature is presented sideways to the magnet, are really greater than when the armature is presented in the usual way, owing to the cylindric curvature of the core. So, if at equal measured distance the reluctance in the circuit is greater, the magnetic flux will be less and the pull less.

It ought also now to be evident why an armature made of iron of a flat rectangular section, though when in contact it sticks on tighter edgeways, is at a distance attracted more powerfully if presented flatways. The gaps, when it is presented flatways (at an equal least distance apart), offer a lesser magnetic reluctance.

Another obscure point also becomes explainable, namely, the observations by Lenz, Barlow, and others, that the greatest amount of magnetism which could be imparted to long iron bars by a given circulation of electric current was (nearly) proportional, not to the cross sectional area of the iron, but to its surface! The explanation is this: Their magnetic circuit was a bad one, consisting of a straight rod of iron and of a return path through air. Their magnetizing force was being in reality expended not so much on driving magnetic lines through iron (which is readily permeable) but on driving the magnetic lines through air (which is, as we know, much less permeable), and the reluctance of the return paths through the air is—when the distance from one to the other of the exposed end parts of the bar is great compared with its periphery—very nearly proportional to that periphery, that is to say, to the exposed surface.

Another opinion on the same topic was that of Professor Muller, who laid down the law that for iron bars of equal length, and excited by same magnetizing power, the amount of magnetism was proportional to the square root of the periphery. A vast amount of industrious scientific effort has been expended by Dub, Hankel, Von Feilitzsch, and others on the attempt to verify this "law."

Not one of these experimenters seems to have had the faintest suspicion that the real thing which determined the amount of magnetic flow was not the iron but the reluctance of the return path through air. Von Feilitzsch plotted out the accompanying curves (Fig. 47), from which he drew the inference that the

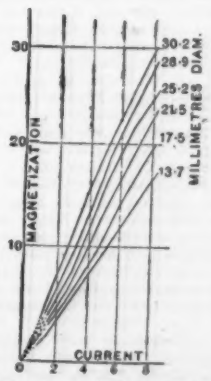


FIG. 47.—VON FEILITZSCH'S CURVES OF MAGNETIZATION OF RODS OF VARIOUS DIAMETERS.

law of the square root of the periphery was established. The very straightness of these curves shows that in no case had the iron become so much magnetized as

* Lectures delivered before the Society of Arts, London, 1890. From the Journal of the Society.

TABLE IX.—EFFECT OF JOINTS IN WROUGHT IRON BAR (NOT COMPRESSED).

H	B				Mean thickness of equivalent air-space for one cut.		Thickness of iron of equivalent reluctance per cut.	
	Solid.	Cut in Two.	In Four.	In Eight.	Centimetres.	Inches.	Centimetres.	Inches.
7·5	8,500	6,900	4,800	2,600	0·0036	0·0014	4	1·57
15	13,400	11,550	8,900	5,550	0·0030	0·0012	2·53	1·00
30	15,330	14,550	12,940	9,800	0·0020	0·0008	1·10	0·433
50	16,400	15,950	14,500	13,300	0·0013	0·0005	0·43	0·169
70	17,100	16,840	16,110	15,200	0·0009	0·0004	0·23	0·087

to show the bend that indicates approaching saturation.

Air, not iron, was offering the main part of the resistance to magnetization in the whole of these experiments.

I draw from the very same curves the conclusion that the magnetization is not proportional to the square root of the periphery, but is more nearly proportional to the periphery itself. Indeed, the angles at which the different curves belonging to the different peripheries rise show that the amount of magnetism is very nearly as the surface. Observe here we are not dealing with a closed magnetic circuit where section comes into account. We are dealing with a bar in which the magnetism can only get from one end to the other by leaking all round into the air. If, therefore, the reluctance of the air path from one end of the bar to the other is proportional to the surface, we should get some curves very like these, and that is exactly what happens. If you have a solid of a certain given geometrical form standing out in the middle of space, the conductance which the space around it (or rather the medium filling that space) offers to the magnetic lines flowing through it is practically proportional to the surface. It is distinctly so for similar geometrical solids, when they are relatively small as compared with the distance between them. Electricians know that the resistance of the liquid between two small spheres, or two small disks of copper, immersed in a large bath of sulphate of copper, is practically independent of the distance between them, provided they are not within ten diameters, or so, of one another. In the case of a long bar we may treat the distance between the protruding ends as sufficiently great to make an approximation to this law hold good. Von Feilitzsch's bars were, however, not so long that the average value of the length of path from one end surface to the other end surface, along the magnetic lines, was infinitely great as compared with the periphery. Hence the departure from exact proportionality to the surface. His bars were 9·1 centimeters long, and the peripheries of the six were respectively 94·9, 90·7, 79·2, 67·6, 54·9, and 42·9 millimeters.

It has long been a favorite idea with telegraph engineers that a long-legged electro-magnet in some way possessed a greater "projective" power than a short-legged one; that, in brief, a long-legged magnet could attract an armature at a greater distance from its poles than could a short-legged one made with iron cores of the same section. The reason is not far to seek. To project or drive the magnetic lines across a wide intervening air gap requires a large magnetizing force on account of the great reluctance, and the great leakage in such cases. And the great magnetizing force cannot be got with short cores, because there is not, with short cores, a sufficient length of iron to receive all the turns of wire that are in such a case essential. The long leg is wanted simply to carry the wire necessary to provide the requisite circulation of current.

We now see how, in designing electromagnets, the length of the iron core is really determined; it must be long enough to allow of the winding upon it of the wire which, without overheating, will carry the ampere-turns of exciting current which will suffice to force the requisite number of magnetic lines (allowing for leakage) across the reluctances in the useful path. We shall come back to this matter after we have settled the mode of calculating the quantity of wire that is required.

Being now in a position to calculate the additional magnetizing power required for forcing magnetic lines across an air gap, we are prepared to discuss a matter that has been so far neglected, namely, the effect on the reluctance of the magnetic circuit of joints in the iron. Horseshoe electromagnets are not always made of one piece of iron bent round. They are often made, like Fig. 11, of two straight cores shouldered and screwed, or riveted into a yoke. It is a matter purely for experiment to determine how far a transverse plane of section across the iron obstructs the flow of magnetic lines. Armatures, when in contact with the cores, are never in perfect contact, otherwise they would cohere without the application of any magnetizing force; they are only in imperfect contact, and the joint offers a considerable magnetic reluctance. This matter has been examined by Professor J. J. Thomson and Mr. Newall, in the Cambridge Philosophical Society's Proceedings, in 1887; and recently more fully by Professor Ewing, whose researches are published in the *Philosophical Magazine*, for September, 1888. Ewing not only tried the effect of cutting and of facing up with true plane surfaces, but used different magnetizing forces, and also applied various external pressures to the joint. For our present purpose we need not enter into the questions of external pressures, but will summarize the results which Ewing found when his bar of wrought iron was cut across by section planes, first into two pieces, then into four, then into eight. The apparent permeability of the bar was reduced at every cut.

Suppose we are working with the magnetization of our iron pushed to about 16,000 lines to the square centimeter (*i. e.*, about 150 lb. per square inch, traction), requiring a magnetizing force of about $H = 50$; then, referring to the table, we see that each joint across the iron offers as much reluctance as would an air-gap 0·0005 of an inch in thickness, or adds as much reluctance as if an additional layer of iron about 1-6th of an inch thick had been added. With small magnetizing forces the effect of having a cut across the iron with a good surface on it is about the same as though you had introduced a layer of air $\frac{1}{1000}$ of an inch thick, or as though you had added to the iron circuit about 1 inch of extra length. With large magnetizing forces, however, this disappears, probably because of the attraction of the two surfaces across that cut. The stress in the magnetic circuit, with high magnetic forces running up to 15,000 or 20,000 lines to the square centimeter, will of itself put on a pressure of 130 to 280 lb. to the square inch, and so these resistances are considerably reduced; they come down, in fact, to about 1-20th of their initial value. When Ewing specially applied compressing forces, which were as large as 670 lb. to the square inch, which would of themselves ordinarily, in a continuous piece of iron, have diminished the magnetizability, he found the diminution of the magnetizability of iron itself was nearly compensated for by the better conduction of the cut surface. The old surface, cut and compressed in that way, closes, as it were, magnetically up—does not act like a cut at all; but at the same time you lose just as much as you gain, because the iron itself becomes less magnetizable.

The above results of Ewing's are further represented by the curves of magnetization drawn in Fig. 48.

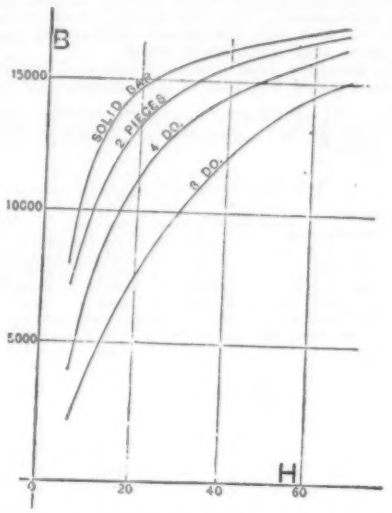


FIG. 48.—EWING'S CURVES FOR EFFECT OF JOINTS.

When the faces of a cut were carefully surfaced up to true planes, the disadvantageous effect of the cut was reduced considerably, and, under the application of a heavy external pressure, almost vanished.

I have several times referred to experimental results obtained in past years, principally by German and French workers, buried in obscurity in the pages of foreign scientific journals. Too often, indeed, the scattered papers of the German physicists are rendered worthless or unintelligible by reason of the omission of some of the data of the experiments. They give no measurements perhaps of their currents, or they used an uncalibrated galvanometer, or they do not say how many windings they were using in their coils; or perhaps they give their results in some obsolete phraseology. They are extremely addicted to informing you about the "magnetic moments" of their magnets. Now the magnetic moment of an electromagnet is the one thing that one never wants to know. Indeed, the magnetic moment of a magnet of any kind is a useless piece of information, except in the case of bar magnets of hard steel that are to be used in the determination of the horizontal component of the earth's magnetic force. What one does want to know about an electromagnet is the number of magnetic lines flowing through its circuit, and this the older researches rarely afford the means of ascertaining. Nevertheless, there are some investigations worthy of study to which time will now only permit me very briefly to allude. These are the researches of Dub on the effect of thickness of armatures, and those of Nickles and of Du Moncel on the lengths of armatures. Also those of Nickles on the effect of width between the two limbs of the horseshoe electromagnet.

I can only now describe some experiments of Von Feilitzsch upon the vexed question of tubular cores, a matter touched by Sturgeon, Pfaff, Joule, Nickles, and later by Du Moncel. To examine the question whether the inner part of the iron really helps to carry the magnetism, Von Feilitzsch prepared a set of thin iron tubes which could slide inside one another. They were all 11 centimeters long, and their peripheries varied from 6·12 centimeters to 9·7 centimeters. They could be pushed within a magnetizing spiral to which either small or large currents could be applied, and their effect in deflecting a magnetic needle was noted, and balanced by means of a compensating steel magnet, from the position of which the forces were reckoned and the magnetic moments calculated out. As the tubes were of equal lengths, the magnetization is approximately proportional to the magnetic moment. The outermost tube was first placed in the spiral, and a set of observations made; then the tube of next smaller size was slipped into it and another set of observations made; then a third tube was slipped in until the whole of the seven were in use. Owing to the presence of the outer tube in all the experiments, the reluctance of the air return paths was alike in every case. The curves given in Fig. 49 indicate the results.

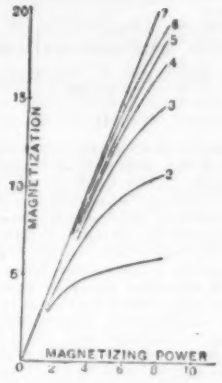


FIG. 49.—VON FEILITZSCH'S CURVES OF MAGNETIZATION OF TUBES.

The lowest curve is that corresponding to the use of the first tube alone. Its form, bending over and becoming nearly horizontal, indicates that with large magnetizing power it became nearly saturated. The second curve corresponds to the use of the first tube with the second within it. With greater section of iron, saturation sets in at a later stage. Each successive tube adds to the capacity for carrying magnetic lines, the beginning of saturation being scarcely perceptible, even with the highest magnetizing power, when all seven tubes were used. All the curves have the same initial slope. This indicates that with small magnetizing forces, and when even the least quantity of iron was present, when the iron was far from saturation, the main resistance to magnetization was that of the air paths, and it was the same whether the total section of iron in use was large or small.

APPENDIX TO LECTURE II.

CALCULATION OF EXCITATION, LEAKAGE, ETC.

Symbols Used.

- N = whole number of magnetic lines (C.G.S., definition of magnetic lines, being 1 line per sq. centimeter to represent intensity of a magnetic field, such that there is 1 dyne on unit magnetic pole) that pass through the magnetic circuit. Also called the *magnetic flux*.
- B = the number of magnetic lines per square centimeter, in the iron; also called the *induction*, or the internal magnetization.
- B_i = the number of magnetic lines per square inch in the iron.
- H = the magnetic force or intensity of the magnetic field, in terms of the number of magnetic lines to the square centimeter that there would be in air.
- H_i = the magnetic force, in terms of the number of magnetic lines that there would be to the square inch, in air.
- μ = the *permeability* of the iron, etc.; that is its magnetic conductivity or multiplying power for magnetic lines.
- A = area of cross section, in square centimeters.
- A' = area of cross section, in square inches.
- l = length, in centimeters.
- l' = length, in inches.
- S = number of spirals or turns in the magnetizing coil.
- i = electric current, expressed in amperes.
- v = coefficient of allowance for leakage; being the ratio of the whole magnetic flux to that part of it which is usefully applied. (It is always greater than unity.)

Relations of Units.

1 inch = 2·54 centimeters;
1 centimeter = 0·3937 inch.
1 square inch = 6·45 square centimeters;
1 square centimeter = 0·1550 square inch.
1 cubic inch = 16·39 cubic centimeters;
1 cubic centimeter = 0·0610 cubic inch.

To Calculate the Value of B or of B_i from the Traction.

If P denote the pull, and A the area over which it is exerted, the following formulæ (derived from Maxwell's law) may be used:

$$B = 4{,}965 \sqrt{\frac{\text{P kilos.}}{\text{A sq. cm.}}}$$

$$B = 1{,}316{\cdot}6 \sqrt{\frac{\text{P lb.}}{\text{A sq. in.}}} \quad \text{or}$$

$$B_i = 8{,}494 \sqrt{\frac{\text{P lb.}}{\text{A sq. in.}}}$$

To Calculate the Requisite Cross Section of Iron for a Given Traction.

Reference will show that it is not expedient to attempt to employ tractive forces exceeding 150 lb. per square inch in magnets whose cores are of soft wrought iron, or exceeding 28 lb. per square inch in cast iron. Dividing the given load that is to be sustained by the electromagnet by one or other of these numbers gives the corresponding requisite sectional area of wrought or cast iron respectively.

To Calculate the Permeability from B or from B_i.

This can only be satisfactorily done by referring to a numerical table (such as Table II. or IV.), or to graphic curves, such as Fig. 18, in which are set down the result of measurements made on actual samples of iron of the quality that is to be used. The values of μ for

the two specimens of iron to which Table II. refers may be *approximately* calculated as follows:

$$\text{For annealed wrought iron, } \mu = \frac{17{,}000 - B}{3{\cdot}5}$$

$$\text{For gray cast iron, } \mu = \frac{7{,}000 - B}{3{\cdot}2}$$

These formulæ must not be used for the wrought iron for tractions that are less than 28 lb. per square inch, nor for cast iron for tractions less than 2¼ lb. per square inch.

To Calculate the Total Magnetic Flux which a Core of Given Sectional Area can Conveniently Carry.

It has been shown that it is not expedient to push the magnetization of wrought iron beyond 100,000 lines to the square inch, nor that of cast iron beyond 42,000. These are the highest values that ought to be assumed in designing electromagnets. The total magnetic flux is calculated by multiplying the figure thus assumed by the number of square inches of sectional area.

To Calculate the Magnetizing Power Requisite to Force a Given Number of Magnetic Lines through a Definite Magnetic Reluctance.

Multiply the number which represents the magnetic reluctance by the total number of magnetic lines that are to be forced through it. The product will be the amount of magneto-motive force. If the magnetic reluctance has been expressed on the basis of centimeter measurements, the magneto-motive force, calculated as above, will need to be divided by

$$1{\cdot}2566 \left(i.\ e.,\ \text{by } \frac{4\pi}{10} \right)$$

to give the number of ampere-turns of requisite magnetizing power. If, however, the magnetic reluctance has been expressed in the units explained below, based upon inch measures, the magnetizing power, calculated by the rule given above, will already be expressed directly in ampere-turns.

TO CALCULATE THE MAGNETIC RELUCTANCE OF AN IRON CORE.

(*a.*) *If Dimensions are Given in Centimeters.*—Magnetic reluctance being directly proportional to length, and inversely proportional to sectional area and to permeability, the following is the formula:

$$\text{Magnetic reluctance} = \frac{l}{A\mu}$$

but the value of μ cannot be inserted until one knows how great B is going to be; when reference to Table II. gives μ.

(*b.*) *If Dimensions are Given in Inches.*—In this case we can apply a numerical coefficient, which takes into account the change of units (2·54), and also, at the same time, includes the operation of dividing the magneto-motive force by 0·4 of π (= 1·2566) to reduce it to ampere-turns. So the rule becomes

$$\text{Magnetic reluctance} = \frac{l'}{A''\mu} \times 0{\cdot}3132$$

Example.—Find the magnetic reluctance from end to end of a bar of wrought iron 10 inches long, with a cross section of 4 square inches, on the supposition that the magnetic flux through it will amount to 440,000.

To Calculate the Total Magnetic Reluctance of a Magnetic Circuit.

This is done by calculating the magnetic reluctances of the separate parts, and adding them together. Account must, however, be taken of leakage; for when the flux divides, part going through an armature, part through a leakage path, the law of shunts comes in and the net reluctance of the joint paths is the reciprocal of the sum of their reciprocals. In the simplest case the magnetic circuit consists of 3 parts (1) armature, (2) air in the two gaps, (3) core of the magnet. These three reluctances may be separately written, as in the table.

	For Centimetre Measure.	For Inch Measure.
1. Armature	$\frac{l_1}{A_1 \mu_1}$	$\frac{l'_1}{A''_1 \mu_1} \times 0{\cdot}3132$
2. The Gaps ...	$2\frac{l_2}{A_2}$	$2\frac{l'_2}{A''_2} \times 0{\cdot}3132$
3. Magnet Core..	$\frac{l_3}{A_3 \mu_3}$	$\frac{l'_3}{A''_3 \mu_3} \times 0{\cdot}3132$

If the iron used in armature and core is of the same quality, and magnetized up to the same degree of saturation, μ_1 and μ_3 will be alike. For the air gaps $\mu = 1$, and, therefore, is not written in.

If there were no leakage, the total reluctance would simply be the sum of these three terms. But when there is leakage, the total reluctance is reduced.

To calculate the ampere-turns of Magnetizing Power requisite to force the desired Magnetic Flux through the Reluctances of the Magnetic Circuit.

(*a.*) *If dimensions are given in centimeters*, the rule is:

Ampere-turns = the magnetic flux, multiplied by the magnetic reluctance of the circuit, divided by $\frac{4}{10}$ of π (= 1·2566).

Or, in detail, the three separate amounts of ampere-turns required for three principal magnetic reluctances are explained as follows:

$$\left.\begin{array}{l}\text{Ampere-turns required to drive N lines through iron}\\ \text{of armature.....}\end{array}\right\} = N \times \frac{l_1}{A_1 \mu_1} \div \frac{4\pi}{10}$$

$$\left.\begin{array}{l}\text{Ampere-turns required to drive N lines through the}\\ \text{two gaps.....}\end{array}\right\} = N \times \frac{2l_2}{A_2} \div \frac{4\pi}{10}$$

$$\left.\begin{array}{l}\text{Ampere-turns required to drive } v\text{N lines through the}\\ \text{iron of magnet core.....}\end{array}\right\} = vN \times \frac{l_3}{A_3 \mu_3} \div \frac{4\pi}{10}$$

And, adding up:

$$\text{Total ampere-turns required.....} = \frac{10}{4\pi} N \left\{ \frac{l_1}{A_1 \mu_1} + \frac{2l_2}{A_2} + \frac{vl_3}{A_3 \mu_3} \right\}$$

(*b.*) *If dimensions are given in inches*, the rule is: Ampere-turns = magnetic flux multiplied by the magnetic reluctance of the circuit. Or, in detail:

$$\left.\begin{array}{l}\text{Ampere-turns required to drive N lines through iron}\\ \text{of armature.....}\end{array}\right\} = N \times \frac{l'_1}{A''_1 \mu_1} \times 0{\cdot}3132$$

$$\left.\begin{array}{l}\text{Ampere-turns required to drive N lines through two}\\ \text{gaps .....}\end{array}\right\} = N \times \frac{2l'_2}{A''_2} \times 0{\cdot}3132$$

$$\left.\begin{array}{l}\text{Ampere-turns required to drive } v\text{N lines through iron}\\ \text{core of magnet.....}\end{array}\right\} = vN \times \frac{l'_3}{A''_3 \mu_3} \times 0{\cdot}3132$$

And, adding up:

$$\text{Total ampere-turns required .....} = 0{\cdot}3132\, N \left\{ \frac{l'_1}{A''_1 \mu_1} + \frac{2l'_2}{A''_2} + \frac{vl'_3}{A''_3 \mu_3} \right\}$$

It will be noted that here v, the coefficient of allowance for leakage, has been introduced. This has to be calculated as shown later. In the meantime it may be pointed out that, in designing electromagnets for any case where v is approximately known beforehand, the calculation may be simplified by taking the sectional area of the magnet core greater than that of the armature in the same proportion. For example, if it were known that the waste lines that leak were going to be equal in number to those that are usefully employed in the armature (here $v = 2$), the iron of the cross might be made of double the section of that of the armature. In this case μ_3 will approximately equal μ_1.

To Calculate the Coefficient of Allowance for Leakage, v.

v = total magnetic flux generated in magnet core ÷ useful magnetic flux through armature. The respective useful and waste magnetic fluxes are proportional to the permeances along their respective paths. *Permeance*, or magnetic conductance, is the reciprocal of the *reluctance*, or magnetic resistance. Call useful permeance through armature and gaps u; and the waste permeance in the stray field w; then

$$v = \frac{u + w}{u}$$

w may be estimated by the Table VIII., or other leakage rules, but should be divided by 2, as the average difference of magnetic potential over the leakage surface is only about half that at the ends of the poles.

RULES FOR ESTIMATING MAGNETIC LEAKAGE.

(I. to III. adapted from Prof. Forbes' rules.)

Prop. I. Permeance between two parallel areas facing one another.—Let areas be A_1'' and A_2'' square inches, and distance apart d'' inches, then:

$$\text{Permeance} = 3{\cdot}193 \times \tfrac{1}{2} (A''_1 + A''_2) \div d''$$

Prop. II. Permeance between two equal adjacent rectangular areas lying in one plane.—Assuming lines of flow to be semicircles, and that distances d''_1 and d''_2 between their nearest and furthest edges respectively are given, also a'' their width along the parallel edge:

$$\text{Permeance} = 2{\cdot}274 \times a'' \times \log_{10} \frac{d''_2}{d''_1}$$

Prop. III. Permeance between two equal parallel rectangular areas lying in one plane at some distance apart.—Assume lines of leakage to be quadrants joined by straight lines.

$$\text{Permeance} = 2{\cdot}274 \times a'' \times \log_{10} \left\{ 1 + \frac{\pi(d''_2 - d''_1)}{d''_1} \right\}$$

Prop. IV. Permeance between two equal areas at right angles to one another.

Permeance (if air angle is 90°) = double the respective value calculated by II. or III.

Permeance (if air angle is 270°) = 1½ times the respective value calculated by II.

If measures are given in centimeters, these rules become the following:

I. $\tfrac{1}{2} (A_1 + A_2) \div d$

II. $\frac{a}{\pi} \log. \frac{d_2}{d_1}$

III. $\frac{a}{\pi} \log. \left\{ 1 \times \frac{\pi(d_2 - d_1)}{d_1} \right\}$

Prop. V. Permeance between two parallel cylinders of indefinite length.

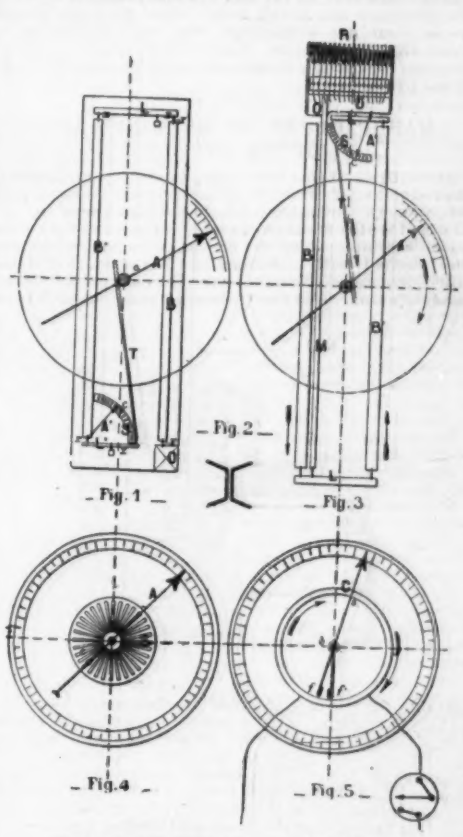
The formula for the reluctance is given above: the permeance is the reciprocal of it. Calculations are simplified by reference to Table VIII.

THERMOMETER WITH ELECTRIC TRANSMISSION.

MR. CHIBOUT has just devised a very sensitive metallic thermometer, which is capable of transmitting its readings to any distance whatever. It consists of two distinct apparatus, viz., of a transmitter or thermometer properly so called and an electric receiver.

The Transmitter.—The transmitter may be employed alone for direct and single readings, or be combined with one or more receivers for multiple readings at a distance.

It consists of a bar, B (Fig. 1), of very expansible metal (of sheet zinc, for example), but of such a section (Fig. 2) that it shall possess the greatest possible rigidity. This bar is fixed by one end to a marble support, O, while the other end is connected with a lever, L, permitting of the amplification of the variations in the length of B. To this lever is attached a second bar, B', similar to B, and the effects of which are added to those of this bar in order to be transmitted to another lever, L', analogous to the first.



THERMOMETER WITH ELECTRIC TRANSMISSION.

The connecting points, x, of the bars and levers are formed simply of a flat steel spring inserted in the pieces to be connected. This suppresses any sort of play and friction in the motion of the pieces and permits of the faithful transmission of the least motions.

A rack, T, mounted by a spring upon the lever, L', gears with a pinion, a, whose axis carries a needle, A, which indicates upon a dial the different variations due to the expansion of the bars, B and B'.

Instead of taking the fixed points of the thermometer upon a rigid and not very expansible support, we may suppress the latter, and have but a simple point of suspension for the apparatus formed of a simple cross piece, D (Fig. 3). The fixed point of the bar, B, and the point of oscillation of the lever, L', would then be taken upon this cross piece, while the point of oscillation of the lever, L, would be taken at the extremity of a very rigid and slightly expansible rod, M, soldered to the cross piece, D.

Upon the lever, L', is fixed a needle, A', with contact, c, which moves before a sector, S, formed of thin plates of copper insulated electrically from each other and reproducing in their *ensemble* the graduations of the dial of the needle, A.

In order to simplify the apparatus, we may place the contact, *c*, upon the needle, A (Fig. 4), and insert the sector, S, in the middle of the indicating dial.

The contact, *c*, with the insulated plates of the sector, constitutes a special circuit for each graduation of the thermometer. To this effect, each plate corresponds to a circuit of different intensity, or rather to a single circuit whose intensity for each of them is modified by means of a divided resistance coil, R Fig. 3).

Consequently, in addition to the direct readings furnished by the needle, A, the thermometer, for each degree or any determinate fraction of a degree, forms a circuit of appropriate intensity which is utilized at a distance for actuating the electric receiver.

The Receiver.—The electric receiver consists of a circular solenoid, C (Fig 5), in the center of which there is a movable axis, *b*, carrying a needle, *s*, and a small bar of soft iron, *f*. Opposite the latter is placed another bar, *f'*, which is stationary.

Under the influence of the circuit closed by the transmitter, and upon which is situated the solenoid, C, the bars, *f* and *f'*, become magnetized in the same direction.

The poles of the same name being in presence of each other, these bars repel each other, and as one of them is stationary, the other describes an angle which is so much the wider in proportion as the intensity of the circuit is greater.

In its angular motion the bar, *f*, carries along the indicating needle, *s*, which marks the amplitude of the motion upon a dial. As the graduations of the latter agree with those of the dial of the transmitter, it follows that the readings received exactly correspond to those sent.

Upon the electric circuit, at a proper point, there is placed a contact that permits of closing the circuit and of causing the receiver to operate.

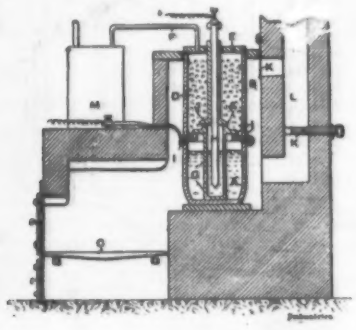
Upon the whole, the receiver is nothing more than a voltameter of a special nature, and, as such, it may serve for the measurement of currents.

By using coarse wire instead of fine for the solenoid we would have an amperemeter. So too, upon giving the solenoid a very elongated elliptic form, and transferring the axis of rotation of the needle to a proper distance from the axis of the bobbin, we would increase the sensitiveness of the apparatus.

Mr. Chibout's thermometer may be advantageously used whenever it is desired to know the temperature of a point distant from the place of observation. Thus, a manufacturer can install in his office as many receivers as there are workshops, etc., that he desires to know the temperature of at every instant, so as to judge as to whether things are going on all right.—*Le Genie Civil.*

MANUFACTURE OF ALUMINUM AND OTHER METALS.

ACCORDING to this invention, by D. Dixon, London, the reduction of an ore is effected by the electrolytical decomposition of a molten halogen salt, one of the elements of which is caused to react on the oxide or other suitable compound of the metal, or on a suitable mixture thereof with carbonaceous material, while the other element of the salt is caused to act on the resulting compound. We illustrate a section of an apparatus



suitable for the manufacture of aluminum according to this invention. A is a suitable plumbago crucible arranged within a chamber, B, and heated by combustion of fuel on a grate, C, the vessel itself forming the negative electrode. D is a retort secured in place upon the vessel, A, and provided with a removable cover, E, for the introduction of a suitable mixture. F is an exit pipe for carbonic oxide generated during the reaction. G is a porous perforated cell, the lower part of which serves to prevent liberation of the negative element of the bath directly below the anode. The upper part of the cell serves as a partition to separate the negative electrode, A, from the positive electrode, H, and is formed with a flange, I, having a depending rim that dips into an annular groove in the bottom of the retort, D, for the purpose of forming a trap therewith. The positive electrode, H, can be of carbon, and dips through the cell, G, into the bath, its upper part being coated with refractory material; for example, a fire clay pipe, that bears upon the cell, G, openings, J, being left between the two for the passage of the gaseous anion from the vessel, A, to the retort, D, by controlling the flow of hot gases and products of combustion from the fire place to the chimney flue, L. M is a condenser into which the carbonic oxide passing off by pipe, F, can be led if necessary for the purpose of removing therefrom any volatile chloride. Example of procedure for the production of aluminum: Into the vessel, A, is introduced a mixture of about 45 parts of chloride of magnesium, 25 parts of chloride of potassium, and 40 parts (all by weight) of chloride of sodium, the chloride of potassium being added to reduce the fusing point and specific gravity of the bath, and the chloride of sodium being used as a diluent. To the mixture may be added about 3 to 5 per cent. of a fluoride, as fluoride of calcium, of potassium sodium, or of aluminum. Into the retort, D, is introduced a suitable mixture of alumina, chloride of sodium, and powdered carbon. The vessel, A, is then heated, to about 800° C., and the vessel, A, and positive electrode, H, are connected to the negative and positive poles respectively of an electric generator, the difference between whose terminals is 6-8 volts. The chloride of magnesium is thereby electrolytically decomposed, the magnesium being liberated at the cathode and rising to the surface of the bath, while the chlorine liberated at the positive electrode passes into the retort through the openings, J, and reacts upon the mixture therein, producing a double chloride of aluminum and sodium. The retort, D, is heated to such a temperature as not to volatilize the double chloride, but maintain it in a liquid state and allow it to flow through the trap at I on to the surface of the bath, where it is reduced by the nascent magnesium, aluminum being obtained and chloride of magnesium being reproduced.

FOR DIPHTHERIA.

"WHY don't they use onions! For goodness sake why don't they use onions! Where do they live? I will go up there to-day and tell them to use onions!" Such were the exclamations of our mother, says the editor of the *Dansers Mirror*, when we reported one day at dinner that a child of Mr. G W. Dudley was dead, and the whole family, including himself, alarmingly sick with diphtheria. Mother was moved to these earnest and interested expressions by a firm belief that she knows several lives saved by the use of onions in diphtheria, one being our sister. In these cases raw onions were placed in a bandage and beaten into a pulp, the cloths containing onion, juice and all, being then bound about the throat and well up over the ears. Renewals may be made as often as the mass becomes dry. In the cases noticed the result was almost magical; deadly pain yielding in a short time to sleepy comfort. The editor adds the wish that this remedy might have a wide enough trial to fully test its usefulness.

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